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JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

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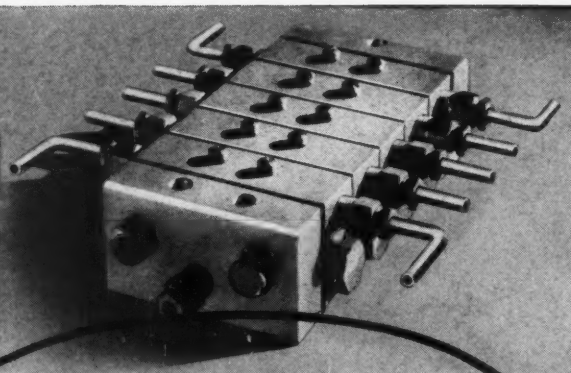

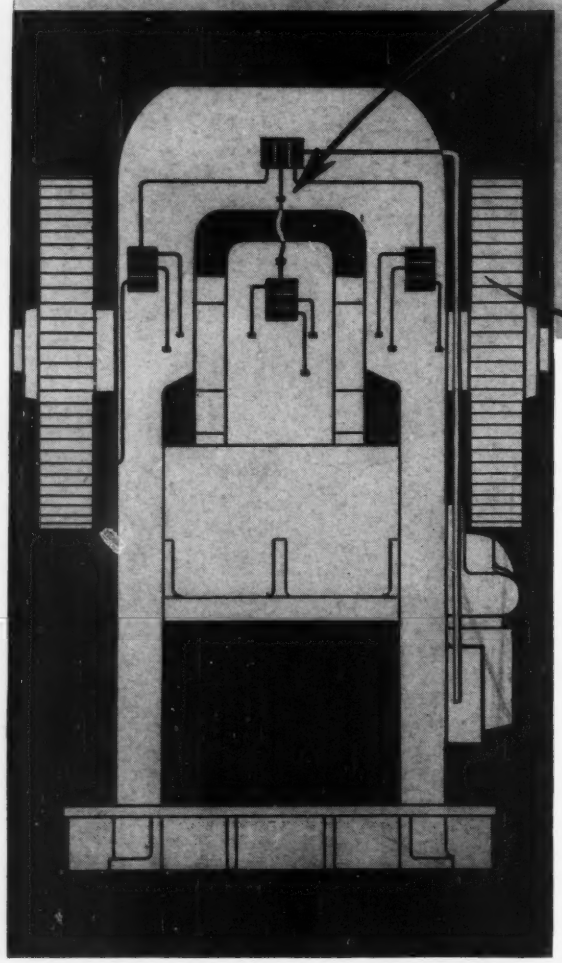

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CONTENTS

Editorial 5

A.S.L.E. Meeting Program 6

Feature Articles

Turbine Oil Maintenance Systems 7
E. M. May

The Mechanism of Pour Point Depression of Oils by Additives 11
Eugene Lieber

Disc Viscometer 15
R. F. McKibben

Field Experiences with Heavy Duty Oils 18
William H. Bean

Potentiometric Determination of Acidity and Basicity in New and Used Petroleum Lubricants (Part I) 23
Louis Lykken

Oils and Lubricants Patent Abstracts 32

New Products and Equipment 31

Departments

Book Reviews 14
A.S.L.E. News 17

News of Sections

New York 36
Philadelphia 36
Milwaukee 36
Chicago 37
Cleveland-Youngstown 37
Pittsburgh 37

Members of the A.S.L.E. 38

A.S.L.E. National Committees and Membership Requirements ... 40

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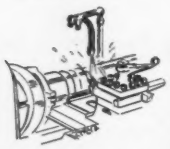

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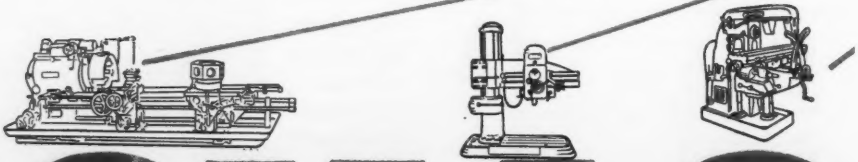

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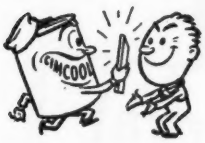

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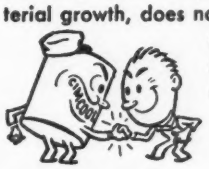

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Editorial

The realization of the lack of unity among engineers is one problem to which each of us should give serious consideration. Under present national conditions some unity should certainly be developed and your editor this month is passing on to you a plan proposed by A. B. Stickney, a past president of the American Society of Refrigerating Engineers, entitled "A National Spokesman for Engineers." His plan certainly merits our serious thought.

"Over 200,000 engineers are members of engineering societies, but not over ten per cent are in any one society. The need for cooperation between societies is being met locally in 35 cities by Local Councils, the combined membership of which is over 100,000. There is much discussion of a national organization of societies, and this article outlines a possible organization by discussing who, how, what, and who will pay for it.

"Membership should be based on the ASA doctrine that anyone having a legitimate interest has an inherent right to participate. Thus Founder Societies, Specialized Societies, Local Specialized Groups, Local Councils and Local Societies or Engineer Clubs would all participate, with representation on Council according to their size. A scheme of organization is outlined.

"Under 'what' the question is posed of what the rank and file of engineers really want, and the answer is given that nobody knows, because there is no mechanism for finding out. To provide such a mechanism, and through it to determine what other activities are desired, a magazine going to all individual members of all member organizations is proposed. Such a magazine would have four major departments. First, policy articles would present the issues, discuss both sides, and invite comment. Second, informative articles on engineering matters of general interest, telling engineers what is going on in the engineering world outside their own fields of specialization, and articles on the technical matters which capture the public imagination from time to time, would be written by authorities but in a style assuming only the basic engineering background. Third, news of the organization, of member organizations, cross-sectional studies of society problems, and news of individual engineers participating in civic activities, would be reported. Finally, a common index of the publications of all member groups, to enable the individual engineer to find out about articles of interest to him which appear in journals he does not normally see, and means to enable him to see them, would be provided.

"It is proposed that each member group pay a $1 subscription for each of its individual members, with provision for nonduplication of payment where a man belongs to more than one society, or where his membership is in a Council by virtue of his membership in a member group. Beyond that, advertising will pay the costs.

"Finally, an Organizing Committee is proposed, to formulate a specific proposal and invite attendance at a general organization meeting."

First Spring Meeting

The American Society of Lubrication Engineers

FRIDAY AND SATURDAY, APRIL 5 and 6, 1946

Stevens Hotel **Chicago, Illinois**

FRIDAY, APRIL 5, 1946

9:00 A. M. REGISTRATION—South End Third Floor Corridor

10:00 A. M. FIRST TECHNICAL SESSION —South Ballroom, Third Floor

"What Is a Lubricant?"—Dr. Henry E. Mahncke, Westinghouse Electric Corp., East Pittsburgh, Pa.

"Centralized Lubrication"—Mr. A. J. Jennings, The Farval Corp., Cleveland, O.

"Automotive Engine Lubrication"—Mr. Arthur F. Underwood, General Motors Corp., Detroit, Mich.

12:30 P. M. LUNCHEON—Tower Ballroom

Speaker: Mr. Harold Vagtborg, Midwest Research Institute—**"Industrial Research Trends"**

2:15 P. M. SECOND TECHNICAL SESSION—South Ballroom, Third Floor

"The Metallurgical Background of Bearing Failure and Boundary Lubrication"—Dr. S. Kyropoulos, California Institute of Technology, Pasadena, Calif.

"The Relationships Between Flow Characteristics and Chemical Structure of Lubricants"—Mr. A. Bondi, International Lubricant Corp., New Orleans, La.

"Characteristics of Typical Polar and Non-Polar Boundary Films Under Stick-Slip Conditions"—Dr. M. Eugene Merchant, Cincinnati Milling Machine Co., Cincinnati, O.

FRIDAY, APRIL 5, 1946

"Lubricating Pressed Metal Production Machinery"—Mr. A. E. Meyer, Meyer Sheet Metal Machy. Co., Los Angeles, Calif.

6:30 P. M. BANQUET—Tower Ballroom

Installation of New Officers

Speakers to be Announced

SATURDAY, APRIL 6, 1946

9:30 A. M. THIRD TECHNICAL SESSION —South Ballroom, Third Floor

"Measurement of Lubricant Film Strength in the Region of Boundary Friction"—Mr. Victor A. Ryan, The Crown Cork and Seal Co., Baltimore, Maryland

"Foaming of Lubricating Oils"—Mr. C. E. Trautman, Gulf Research and Development Co., Pittsburgh, Pa.

Title to be Announced—Dr. G. H. von Fuchs, Shell Oil Co., Wood River, Ill.

"Surface Conditioning of Metals in Friction"—Mr. Paul W. Wendt, Grafo Colloids Corp., Chicago, Ill.

"The Development of Lubricating Systems as Applied to Engines"—Mr. C. A. Winslow, Winslow Engineering Co., Oakland, Calif.

12:30 P. M. ADJOURNMENT OF CONVENTION

2:00 P. M. BUSINESS MEETING OF DIRECTORS AND OFFICERS OF THE SOCIETY

Programs of the Convention have been mailed to all members of the Society and members who have not yet done so should make their hotel reservations at once. Preliminary estimates indicate that a large number of members and guests will attend the meeting.

Turbine Oil Maintenance Systems*

By E. M. May

Bowser, Inc.

Because of high speeds, heavy bearing pressures, high temperature and other factors, the lubricating oil in large turbines must be carefully maintained. This timely article suggests equipment and methods to accomplish this.

* * * * *

Historical

TRACING briefly the development of turbine oil treatment systems over the span of the last thirty years, we find at the inception of this period that horizontal turbines were just beginning to supersede, because of design, cost and performance, etc., the vertical units theretofore built. The oil systems were all of the force feed type, exceedingly small in capacity as compared to the circulation rate, and no oil maintenance was employed, other than to cool and strain the oil. Oftentimes the turbine systems circulated the total amount of oil once every minute and a half or two minutes.

The oil deteriorated rapidly as was indicated by high temperatures of bearings and/or the oil, or by burned out bearings and other mechanical troubles. When this occurred, the operator did one of the following:

1. Changed the complete charge of oil.
2. "Sweetened" the oil, i.e., small quantities were removed and make-up oil added.
3. Batch filtered the oil in a gravity filter. (Fig. 1.)

In about 1915, a decided step forward was made by the introduction of the continuous by-pass filtration system, whereby part of the oil was by-passed through a vented overflow to a gravity filter equipped with an automatic water separator. (Fig. 2.)

Shortly thereafter centrifugal separators began to be used for purification of turbine oil. These could also be operated on the batch as well as the continuous by-pass systems in a similar manner to gravity filters.

In the early 1920's the discovery that soluble sludge (that product of acidity caused by aeration, heat and moisture which is invisible in the oil at bearing operating temperatures) could be precipitated at room temperatures, brought forth another improvement in oil treatment. At that time the two compartment precipitation tank was evolved. The practice is to have each compartment large enough to hold all of the oil in the turbine and by-pass systems. Periodically this oil is "dropped" into the empty side of this tank and as the temperature decreases the sludge is precipitated. (Fig. 3.)

These tanks are made of steel plate, with bottoms sloping towards a cleanout of ample size. A float suction, the low point of which is above the maximum precipitated sludge level, is connected to a transfer pump for the return of the oil to the turbine.

These tanks also are fitted with coils which may be used for either cooling or heating the oil as may be necessary, and test cocks to determine the sludge level.

Galvanized iron is no longer used in oil tanks or filters as it has been definitely determined that zinc soaps form and invariably cause corrosion. This is especially true if there is any moisture in the oil.

As to pumps used in turbine oil filtration systems, it is considered bad practice to employ centrifugals because of the churning effect. Should water and/or soluble sludge be present in the oil a centrifugal would aggravate an already bad condition. Reciprocating or positive displacement rotary pumps are usually preferred.

Returning to the subject of treatment of the oil itself and its relation to the operation of the turbine, there have been great improvements in turbine lubricants as well as the lubricating systems, thus automatically requiring that more thought be given to economical oil maintenance. These improvements in turbine oil quality made by the petroleum industry together with the improvements in turbine design and size, the stepping-up of steam pressures and temperatures, prolonged operating periods between shutdowns, etc., have brought about a demand for more efficient foolproof, economical methods of turbine oil conditioning.

Turbine sizes have increased to the place where 60,000 to 80,000 KW units are not unusual. Steam pressures and temperatures have been raised to where 1250 pounds and 900 F are the rule rather than the exception. With these higher temperatures and pressures, lubricating systems have been radically changed to a point where past practices with lubricating oil and oil system maintenance must be discarded.

On certain units all high pressure oil piping is contained within the low pressure or return oil piping, to guard against fire hazards through oil leaks. The lines are fabricated and assembled in place by welding, making it impossible to dismantle them for cleaning.

In other turbines many of the oil passages are cored into the bearing and governor casings, again presenting the necessity of perpetual oil system cleanliness, hence the need of oil conditioning.

Many turbine oils are being produced that resist oxidation to a marked degree. They show a stubborn resistance to acid formation, hence resistance to forming or promoting true emulsions. They cannot,

* *Read before the November 28, 1945, meeting of the Chicago Section of the A.S.L.E., by H. E. Bergman of the Chicago Office of Bowser, Inc.*

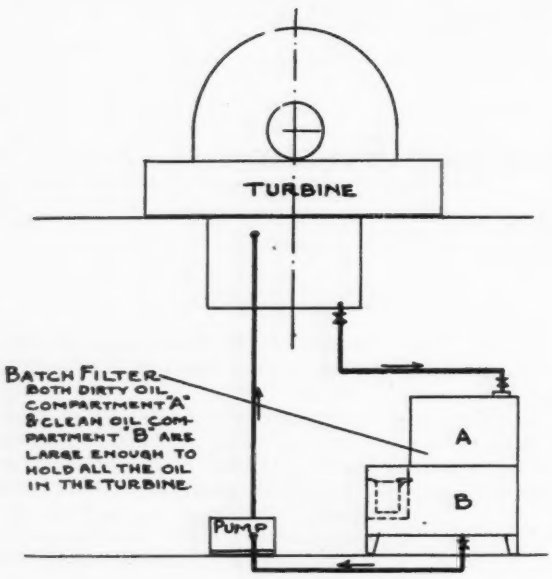
TURBINE
BATCH FILTER
BOTH DIRTY OIL COMPARTMENT "A" & CLEAN OIL COMPARTMENT "B" ARE LARGE ENOUGH TO HOLD ALL THE OIL IN THE TURBINE.
A
B
PUMP

Figure 1. Batch System.

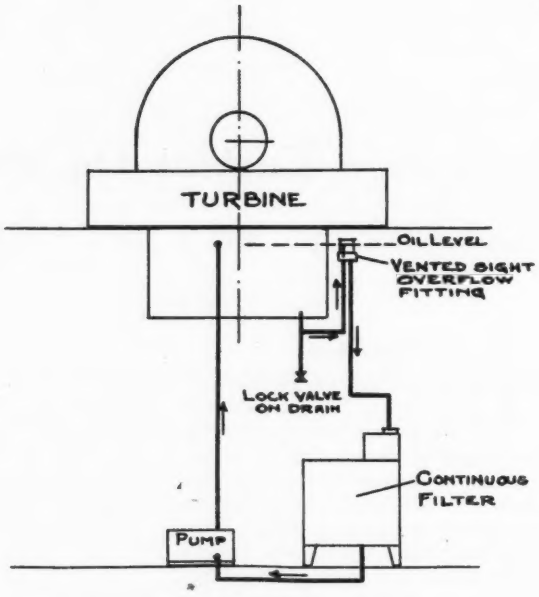

Figure 2. Continuous By-Pass System.

however, prevent the entrance of foreign impurities, water, metallic oxides, etc. Lubricants of this type, however, respond to economical conditioning; their useful life being greatly prolonged by simple means of oil maintenance.

All these advancements have done much to improve operating conditions, yet the fact remains that service conditions are more severe, shut downs are more costly. Machine design has made obsolete old practices of oil system maintenance, all of which placed limitations on satisfactory oil performance.

A general knowledge of what the service conditions are and how they affect the operating cost of any turbine, is necessary before a correct understanding of the needs of oil conditioning can be fully appreciated.

Conditions of Normal Turbine Operation and How They Affect the Lubricating Oil

This is a subject to which a great deal of attention is being given by the leading oil companies, turbine builders and the equipment operators. The trend of installing high pressure "topping" units in present central stations and industrial plants, new high pressure condensing units at new stations is acting as a stimulus to the already rapid strides which are being made in the production of electrical energy at the lowest possible cost without needless interruptions.

The newer installations, by the very fact that they are economical, produce revenue only when running. Shut down costs for any type of functional failure are as great in comparison of time and expense as the newer machines are economical.

Uninterrupted operation as affected by lubrication of the present day turbine can be presented more clearly and logically by treatment under the following headings:

(a)Lubricating Oil Functions:

The journal speed of a steam turbine is higher than in any type of prime mover. The high rubbing speeds are accompanied by a certain amount of heat conducted to the journals from the steam area of the rotor. Consequently, the film of oil in the bearings must never be broken as it insulates the hot journal from the bearing surface at the same time separating the two surfaces so that metal to metal contact cannot occur. Large turbines are again being built to operate at 3600 rpm. Therefore with this constantly decreasing time interval and at higher operating temperatures, the oil must absorb and dissipate or transfer this waste heat thereby keeping the bearing surfaces protected and relatively cool. To insure this, turbines are equipped with self-contained oil circulating systems fitted with pumps whose capacities are greater than the demands for lubrication alone, a portion of the oil acting as a cooling medium for the bearings.

The circulating system provides not only efficient lubrication of all bearings, but governor gear and oil pump drives. In turbines driving through speed reduction gear sets the gear, turbine and generator lubrication systems are integral. A further function of the lubricating system is to operate governing valves, gland seals on gas cooled generators, back pressure and bleed off valves, vapor exhausters, etc.

Any interruption of the oil supply will seriously impair the function of the various parts enumerated, and a momentary failure of the oil film in a bearing produces disastrous results.

(b) Effect which Lubricating Oil Maintenance has on Modern Power Plant Economies:

The production of each kilowatt at the lowest possible cost, month in and month out, is the aim of every power engineer. The entire power industry and power engineering profession search for every means to increase plant economy.

Power plant economies demand that turbines be operated continuously for extended periods, and that inspection down time be as brief as possible, i.e., any preventive maintenance shortening down time is practical economy.

This preventive maintenance particularly applies to lubrication, which is one of the most vulnerable features of operation. There must be continuously maintained the

widest possible margin of safety in the oil and lubricating system. Costs of periodic shut down for cleaning of coolers and lubricating system are prohibitive, unnecessary, and, as pointed out, the manual cleaning of the newer oil systems is quite impossible.

This preventive maintenance is closely associated with correct oil conditioning.

(c) Water, Emulsions and Corrosion:

Moisture finds its way into the oil in a number of ways despite the precautions taken by manufacturers in the construction of gland seals. These glands are sometimes fitted with carbon packing rings, held against the shaft by springs, labyrinth rings and leakoffs, water runner seals or a combination of both. Despite all the ingenuity of design and construction, moisture will at times enter the oil system from this source.

Some moisture will enter the system from unequal temperatures prevailing between inner and outer surfaces of sumps, gearing and bearing casings. Another way in which it may get into the system is through cooler leaks.

In turbines where small water tubes are imbedded in the bearing metal as a further aid to cooling, "sweating" of the pipe connections in the bearing housing or slight leaks may occur, providing another source of moisture.

Water alone is not injurious to clean oil. It will, however, in many instances produce corrosion of the finely machined and fitted parts of governing mechanisms, gears, etc.

Water combined with products of oxidation, air, heat, metallic oxides, dust and fly ash, etc., promotes further oxidation which in the newer type oils, forms a brownish or light colored sediment which adheres to cooler tubes and any relatively cool surfaces such as bearing housings, walls of oil sumps, oil lines, etc.

Many of the newer turbine oils contain addition agents which greatly retard oxidation and its resultant formation of organic acids. Such lubricants show extremely long life where careful means are provided to continuously free the oil body from contamination impurities.

In service, metallic oxides, finely divided products of oil oxidation and other impurities, if allowed to remain in the circulating system will combine with and consume these protective addition agents leaving the lubricants without protection. However, until such protective agents are consumed, the acid value of these oils will remain practically constant.

Other turbine lubricants not containing added oxidation inhibitors show a progressive but gradual climb in acidity, which if unchecked or permitted to exceed certain values, will tend to precipitate waxlike deposits throughout the entire system. They will also show a strong affinity for moisture, often forming disastrous emulsions.

Oxidation

Regardless of the degree of refining, the crude source, or the protective measures taken to prevent oxidation, it will take place. Oxidation can be retarded but cannot be completely stopped. In addition to inhibitors, methods of refining, etc., the rate of oxidation, and hence oil decomposition can be further controlled and greatly retarded by oil conditioning. Another aspect of the subject is that the life of oxidation inhibitors, whether they be naturally occurring or additives, is more or less limited. After they have been consumed or destroyed in service the oils deteriorate very rapidly.

When oil oxidizes, the products formed are many and complex in structure. Much of the material is soluble both in oil and water, some are oil soluble only, while others reform into wax-like solids that at the start are colloidal in nature.

During their early formation they are not usually apparent and give no trouble from an operating standpoint. In fact it is often quite difficult to measure their values by laboratory tests. As the oxidation products accumulate in the oil, unpredictable concentrations are reached where serious damage to both oil and equipment may occur.

It has been found after prolonged study, both in the laboratory and in actual service operations, that if the water soluble and solid colloidal products of oxidation are continuously removed from the oil, that oil life becomes indefinite and at no time can they become operating hazards through sludging, the formation of emulsions or system fouling.

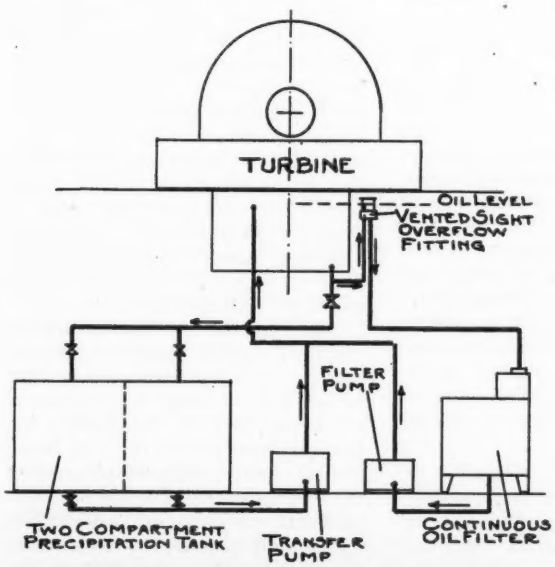

Figure 3. Combination By-Pass Batch System.

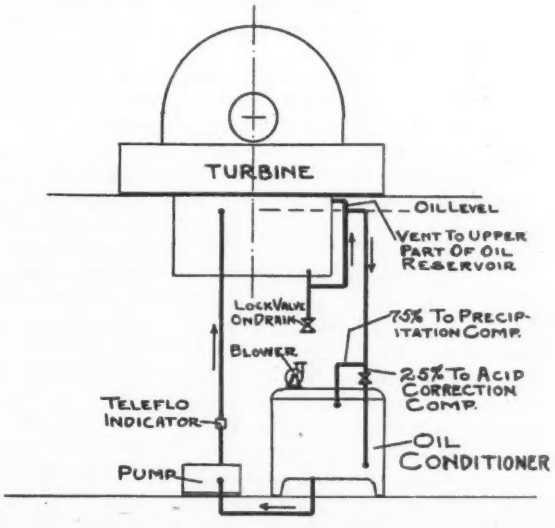

Figure 4. Conditioner System.

Emulsions

For all practical purposes an emulsion can be defined as a mixture of liquids, solids, air, etc., insoluble in one another. Thoroughly mixed they combine both mechanically and chemically and are held in suspension forming emulsions of varying types depending on the materials involved in the mixture. They will range from the "milk like" oil-in-water emulsions used as cooling fluids in machining and grinding to the dark tough "liver like" emulsions often found in the bottom of sump tanks. By removing water soluble acids, water and colloidal solids, emulsions cannot form, because the very ingredients necessary to their formation cannot accumulate.

The various agents which reduce the life of turbine oil may be summarized as follows:

1. Very rapid oil circulation.
2. Moisture from gland leakage, oil coolers, condensation from moisture in the air.
3. Intimate contact with heated air.
4. Constant oxidation of the metal surfaces in producing metallic oxides.
5. Oxidation of the oil itself.

The effects of these reactions tend to degrade the lubricant and foul the oil system. A few of the results are:

1. Deposits in governor systems causing erratic control.
2. Corrosion of important, highly finished machine parts, often becoming very serious.
3. Emulsions and/or sludges.
4. Deposits on cooler tubes, in piping, bearing housings, turbine reservoir, etc.
5. Possible stoppage of oil flow to bearings, governor mechanisms, etc.
6. Costly cooler and oil system cleaning.
7. Short life of lubricating oil.
8. Preventable machine down time.

Oil Conditioning

One of the efforts to prevent the above results has been water treatment of the oil. To aid in the separation of minute solids and to dissolve water soluble impurities, many operators introduce a stream of hot fresh water with the oil going to the cleaning unit. This aids materially in the effectiveness of such cleaning methods. The fact remains, however, that such effectiveness depends mainly on the carefulness of the attendant, requiring such close supervision by trained personnel, often requiring extra help for such work.

Among the positive and economical means of oil maintenance designed to insure the operator of perpetually clean lubricating systems, has been the use of a unit known as an "oil Conditioner." This device has been found effective in prolonging oil life and maintaining clean oil systems at the lowest possible cost and with little or no attention on the part of the operator.

This system provides a means whereby some of the oil in service is withdrawn from the lowest point in the oil system, washed in clean hot water in thin films and without violent agitation, thoroughly filtered at very slow rates and returned clean and dry to the turbine system—in a simple, sure and inexpensive method. (Fig. 4.)

In the water wash compartment of the conditioner the water precipitates the larger solid particles from the oil, the microscopic particles coalesce, giving up mechanically entrained water and the water soluble products of oxidation are dissolved. All moisture is removed by the use of dehydrators with large absorptive power and automatic water ejectors. The oil then passes to the filter compartment where vertically positioned cloth elements catch the fine solids and insoluble products of oxidation. No appreciable pressure being involved or agitation encountered, the fine solids further coalesce and either cling to the outer side of the filter element or drop off and precipitate to the bottom of the filter chamber where they are readily withdrawn.

A very small exhaust ventilating fan on top of the conditioner removes acid laden moisture and oil vapors.

Often new oils placed in a comparatively clean system lose color rapidly and become cloudy in appearance, indicating clearly that the clean lubricant is dissolving and dislodging formations that could not be removed manually. With an Oil Conditioner in service these visual impurities are progressively removed from the oil stream, the oil maintained in "new" condition thereby hastening the thorough cleaning of the entire system.

Once the system is "clean" it is then only necessary to continuously remove the normal quantities of contaminating impurities such as dust, metallic oxides, water, etc. Their removal from the oil stream positively prevents deposits in pipe lines and coolers and system areas where the oil is quiescent.

Some of the advantages of this type of oil conditioning system are as follows:

1. Continuous, automatic, foolproof, trouble-proof, and positive performance.
2. No high speed expensive machinery—in fact, no moving parts other than the oil pump.
3. No fire hazard. No open connections at the turbine or near high pressure steam lines. (The system can be placed either above or below the turbine or in an adjoining room.)
4. Flexibility.
5. No down time for cleaning.
6. Negligible operating and maintenance costs — current for fractional H.P. motor driving pumps — filter element cleaning — filter medium replacements at long intervals.
7. No oil loss during operation or cleaning.
8. Heating elements are in water compartment (positively eliminating over-heating or "hot spots." Either steam coils or electric heaters can be used.
9. No agitation or additional oxidizing influence.
10. Extraordinarily low oil consumption for turbines using this system.
11. No down time for cooler and oil system cleaning.
12. Costs a minute fraction of the turbines they protect — often less than the cost of the batch of oil in the system.

While this article attempts to cover briefly the development of turbine oil maintenance systems during the past thirty years, it has not specifically differentiated between those used in central stations and industrial plants. The line of demarkation is not very clear as some of the former operate generating units as small as 5000 KW or less, while some industrial power plants have single units as large as 30,000 KW or in one case 110,000 KW.

All of the various types of systems described may be found in operation today, but as a general rule the turbines in the average size industrial plant use only the continuous by-pass clarification system. The larger central station units employ either the by-pass system plus the two compartment precipitation tank or the increasingly popular oil conditioner described in the latter part of this article.

The Mechanism of Pour Point Depression of Oils by Additives

By EUGENE LIEBER
Technical Director, Nox-Rust Chemical Corporation, Chicago

In this paper the author reviews and analyzes the several theories which have been advanced to cover the mechanism by which pour point depressant additives perform their function, and suggests a course to be followed in further investigation.

* * * * * * * * * *

THIS paper presents a critical survey of recent literature on the theory of pour point depression. Below a certain minimum temperature lubricating oils having high paraffin wax content congeal. It has been shown that at this point precipitated wax crystals have formed an interlocking network and the oil is bound up by being trapped within the structure as well as absorbed on the surface of the crystals. Davis and Zimmer[11] believe that a pour point depressant such as Paraflow prevents congelation of the oil by being preferentially absorbed on the wax crystal surface, preventing growth of the crystals and resulting congealing of the oil. If loss of fluidity of the oil at the pour point is considered to result from gel formation due to the solvation action of the oil on the wax crystals, an additive such as Paraflow may have the effect of destroying the solvation films of oil by forming one of its own, thus causing coagulation of the crystals and precipitation before a wax oil gel can be formed. It is known that the molecules of liquids frequently have a tendency towards orientation much the same as solvents. An orientation of its molecules similar to those of the wax, may explain why Paraflow is absorbed preferentially on the wax crystal surfaces.

Today, more than ever, high power engines are being required to work under drastic conditions. Lubrication of the moving parts at low temperatures is one of the most essential problems to be faced in connection with motors, particularly with automobile engines. Oil must have a certain degree of fluidity in order to enable it to reach all rubbing parts quickly on the starting up of the motor. If the lubricant thickens at low temperatures, more power is absorbed in moving metallic surfaces over one another, and a high internal friction results with possible ultimate seizure of the parts. Neither can a low-viscosity oil be used, since it will possess other disadvantages. Thus a lubricant is required which possesses a small change of viscosity with temperature, that is, a high Viscosity Index (VI).[3,6]

Crude oil stocks from which the high grade oils are obtained frequently contain a relatively high percentage of dissolved solid hydrocarbons (paraffin). On cooling to a certain temperature, this paraffin and other high molecular weight compounds tend to precipitate, congealing the oil. Such stocks may thus have a pour point above the standard maximum.[10] Normal paraffin base oils have pour points of 25-30 F,[1] quite a bit above the minimum temperatures of winter weather in northern climates. Such high pour oils have difficulty reaching the rubbing parts during cold starting, and, consequently, contribute to excessive wear in the engine.[11]

The congealing of lubricating oils is due to the precipitation of paraffin and other waxes dissolved in the oil, as mentioned above. In cooling, these crystals form a plastic gel of wax and oil.[10] This has been demonstrated by passing an oil cooled to 15-30 F below its pour point through a homogenizer to break up the wax structure.[10] An immediate reduction of 20 F in the pour point resulted, although the effect was not permanent. On storage, the wax gradually recrystallized, the oil recovering its original pour point.[10]

Until recently, the only effective method of permanently decreasing the pour point of lubricating oils was the practice of dewaxing. Even dewaxed oils, however, show crystallization at extremely low temperatures[9] since all the wax cannot be removed. Furthermore, dewaxing has several ill effects on the quality of the oil. It has been found to lower the lubricating quality and oxidation stability as well as increase volatility.[11] An added disadvantage is the unpleasant surprise the user receives when a dewaxed oil very abruptly congeals below the new pour point obtained by dewaxing.

A third method developed in the last decade is the use of additive agents which act within the oil to keep it from congealing. The Japanese have experimented with hardened fish oil in this connection.[8] Dilution with small amounts of kerosene in extremely cold weather has been found to be very effective.[9] However, due caution must be exercised for protection of the motor in this practice since the effect of dilution on viscosity varies with the oils. In 1931,[11] Paraflow was introduced as a pour point depressant. The addition of small quantities (up to 2%) of this hydrocarbon has replaced to a large extent the practice of dewaxing.

Paraflow in quantities of from 0.25% to 1.5% added to a wax-containing motor oil will lower the pour point some 40-60 F or from about 30 F to below 0 F and without the accompanying disadvantages of the dewaxing process.[11] Paraflow, discovered in the investigation of synthetic motor oils, is a viscous hydrocarbon of high paraffinic content and with an analysis similar to Pennsylvania bright stocks.[1,11] Paraflow has no effect, aside from pour point reduction on the other properties of the oil.[11]

The mechanism by which Paraflow functions as a pour point additive is not well understood. Only a few theories have been offered and literature on the subject is sparse.

According to A. M. Ravikovich, oils may be classed as (1) "turbid," or (2) "non-turbid." In the former (1) the cloud point is considerably above the pour point of the oil; but in the latter (2) pour point and cloud temperatures coincide. All dewaxed oils belong to the non-turbid group by Ravikovich's classification.[10] According to Einstein

$$\eta = \eta_1 \left(1 + 2.5 \frac{V'}{V}\right)$$

where η = viscosity of colloidal system (the oil with paraffin in suspension),
η_1 = viscosity of pure solvent,
V' = total volume of all particles in disperse phase and V = volume of whole solution.

In colloidal systems such as wax particles dispersed in oil, the phenomenon of solvation is frequently met. That is the solute particles (i.e., paraffin) are surrounded by liquid films of the solvent (oil) which have the effect of increasing the volume of the solid particles in proportion to the degree of their dispersion in the system. All the other factors affecting viscosity of the system are included in the term V'. As the mixture is cooled an increase in viscosity is observed. V' increases rapidly as the pour point is approached while at the same time η_0 increases with falling temperature. Thus η^r (relative viscosity $\frac{\eta}{\eta_0}$) increases, but is always something less than 3.5 by the Einstein equation. According to Ravikovich, the explanation of non-turbid oils is that the value for V' is so large that the oil coagulates as soon as V' attains this value. In the turbid oils, the precipitated paraffin particles have a different shape and are surrounded by "other liquid covers." V' is of different magnitude and, therefore, the viscosity does not increase enough to congeal the oil, which remains mobile in spite of precipitated wax. If it is a lesser degree of solvation to which Ravikovich refers by "other liquid covers," he seems to have no theories to offer as to why the solvation should be so different in two oils. The addition of a pour point depressant changes the form of the solid particles, the size of the oil films and "other values which make up V'" reducing this value and thus lowering the pour point. Again no suggestion is given for the physical mechanism of this vague effect. Ravikovich suggests that in non-turbid oils (where V' is larger than needed to produce congelation) additives may be ineffective because, although V' is reduced somewhat, they are not capable of taking up "available viscosity reserve." This theory is supposed to explain why pour point depressant additives lower the pour point of turbid oils such as Emba crude, and are ineffective in non-turbid oils such as Surahkany bright stock. It, however, is not in agreement with American data on the matter since Ravikovich includes all dewaxed oils in his non-turbid class and Paraflow has been found to improve the pour points of even dewaxed oils.[9] "In many instances the effect of pour point depressants surpasses the improvement wrought by dewaxing, and it has been found highly recommendable to mix additives even to dewaxed oils."

On the whole, Ravikovich's theory seems inadequate and vague. If Einstein's equation holds (and that is questionable since the theory was developed for systems where the particles are rigid spheres, large in relation to the particles of solvent, but small compared to the dimensions of the viscometer[13]) it is obvious that an increase in V' will increase the pour point value, and vice versa, but this does not explain the mechanism of the effect.

Another theory more definite than this has been put forth by Davis and Zimmer.[11] Examination of different stocks under a polarizing microscope equipped with a cold stage, indicated that below the pour point, wax-free oils are amorphous solids, Pennsylvania neutrals interlocking networks of paraffin crystals and a high pour, and bright stock blend to have comparatively small petrolatum crystals. From this data it was concluded that crystalline networks are not the sole cause of high pour points in waxy oils. That it is one cause, however, was demonstrated by a significant but temporary lowering of the pour point after the chilled oil was passed through a homogenizer. In the oil-petrolatum gel, the oil is held firmly by the wax, probably by surface absorption as well as being entrained in the crystalline network.

In a study of the effect of Paraflow on waxy oils, the following observations were made:

(a) The addition of Paraflow results in only slight lowering of the cloud point but a decided decrease in crystal size.

(b) Paraflow retards growth in proportion to its concentration in the oil up to 2%.

(c) There is no evidence of any alteration in the crystal system although shape of the individual crystals may change a little.

(d) The reduction in size due to Paraflow is only slight in bright stocks or their blends which normally contain relatively small petrolatum crystals. The pour point of these oils is also decreased by Paraflow.

Thus from (a), it may be said that an effect of Paraflow is to cause crystals to precipitate which are too small to form an interlocking network to enmesh the oil. (b) and (d) indicate that this crystal size reduction is not the only effect Paraflow has on the oil. If oil adsorption has a part in congealing at the pour point of oils, then Paraflow must have an effect on the amount of oil that is adsorbed.

Thus Paraflow may be said to have two effects on oil:

(a) reduction of crystal size,
(b) decrease in the amount of oil held by the wax.

In the first case, the postulate that Paraflow functions as a seed former was rejected as improbable because wax-free Paraflow shows no indication of crystallization even at –40 C.[1,11] The authors of the paper "Paraflow" (Davis and Zimmer[11]) seem to think that the Paraflow coats the growing crystals and is preferentially absorbed instead of the oil since the amount of oil remained after chilling and removal of wax increases directly with the amount of Paraflow added originally. Two per cent of Paraflow appears to give maximum pour reduction, and up to this percentage the greater

proportion of Paraflow is removed with the wax after chilling. In sudden chilling Paraflow fails to reduce pour points by even as much as 2%. Perhaps this is due to increased crystalline surface and not sufficient Paraflow. Or perhaps Paraflow does not have time to be sufficiently absorbed.[1,11] Zimmer, Davis and Frolich[1] reached the conclusion that the action of Paraflow is analagous to dehydration or coagulation of the colloid solution by electrolytes. That is, the effect is to agglomerate the wax particles. This has been found to be true of all pour point depressants examined thus far.

Therefore, the action of pour point depressant additives consists chiefly in coating the crystal surfaces by adsorption, stopping their growth and displacing the layer of adsorbed oil.[11]

Bondi[9] seems to agree with this general explanation but attacks the problem in a more quantitative light. Here a comparison is made of the amounts of wax separated out in solid phases calculated by two different methods. When wax precipitates out, a definite heat of solidification is liberated which may be measured. This heat of solidification, L, may be determined by graphical analysis of cooling curves. L of the pure wax may be determined separately, and by comparing the value with that obtained in oil, the amount of wax in the quantity of oil used is arrived at readily. If the ratio of the viscosity of the wax particles in the oil to that of the pure oil solvent is determined, Bondi claims the amount of wax precipitated can be calculated from the Einstein relationship: $\eta/\eta^1 = 1+2.5$, if the particles in suspension are assumed not to be in contact with one another. Assuming η =viscosity of solution and η^1 viscosity of pure solvent as is conventional, no such equation is to be found in the reference given by Bondi.[12] The relation as quoted from Gemant[12] and also from Lauffer[13] is

$$\eta/\eta^1 = 1 + 2.5\ nV$$

where n = number of particles,
V = volume of one particle
η = viscosity of solution,
and η^1 = viscosity of solvent.

(In Lauffer's article nV is replaced by G, volume fraction of solute or volume concentration, a more general statement, since the above equation would have to be true only for a given quantity of solution. Lauffer gives this relation as preferable also, because it is known that solvation causes particles to occupy a larger volume in solution than where there is no such effect.)

In order for Bondi's equation to be valid, the volume of concentration of wax in the oil must be one or the amount of oil very small as compared to the amount of wax. Obviously, this is not true.

Moreover, it is quite apparent that since viscosity of solutions depend on the amount of solute, the relative viscosity η/η^1 cannot be constant. It is the intrinsic viscosity, a characteristic of the solute material which Einstein related to the constant 2.5.

Aside from this, the Einstein equation was developed for perfectly spherical particles.[13] Experiment shows that this relation does not always hold, even approximately. The intrinsic viscosity has been found to vary with the solvent and with molecular weight of the solute.[13]

Assuming, however, that the correct Einstein relation was used and is valid in this case, the difference between the values of wax quantity precipitated, calculated from the heat of solidification data, and that from viscosity is an indication of the resistance of the crystalline gel structure to shearing stress: that is, the viscosity of the wax and oil system is not true viscosity since it is not a true solution but rather a measurement of the rigidity of the structure.[9]

On the empirical side, viscosity measurements were taken on several different stocks, as shown in Figure 1.

From this data it is observed that the pour point depressing action of dewaxing is suddenly lost below the temperature of dewaxing. Curve (2) indicated that pour point depressants cause a true lowering of the pour point and show no sudden loss of their effect below a certain temperature.

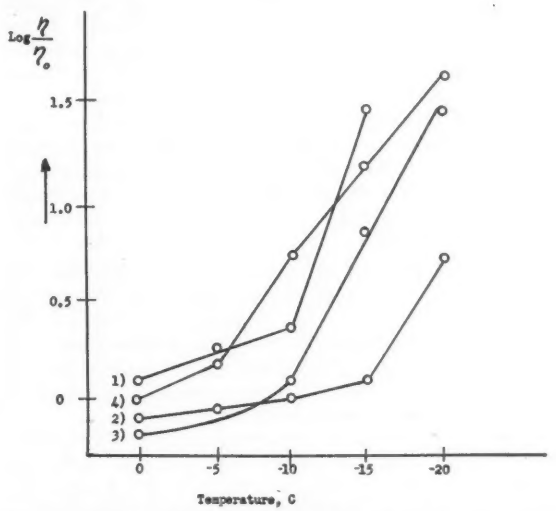

Figure 1. Viscosity Measurements of Several Different Stocks.
4) Unrefined oil (standard Pennsylvania bright stock and 150 Penn. neutral).
1) Same mixture after extraction with nitrobenzene.
3) Same as (1) after dewaxing by the acetone-benzene method at —10 C.
2) Pour point depressant added.

The theory of pour point depressant effect which Bondi derived from this data is essentially the same as the adsorption theory of Davis and Zimmer[11,1] described above. Thus, concludes Bondi, almost any oil soluble surface active agent could be used as a pour point depressant, although some might have other adverse effects upon oil properties such as oxidation stability, etc. The validity of this can only be tested by experiment.

To go a little farther into a possible explanation for the action of pour point depressant additives, one might regard it from the viewpoint of solvation. Little is known of the mechanism of solvation but several theories have been proposed. Margaritov[14] defines solvation as "the ability of dissolved or suspended substances to bind part of the dispersion medium." He further breaks solvation down into two types:

(1) *Surface* — "The molecules of dispersing medium are arrested at the surface of the particles of the disperse phase by adsorption forces, the ability of which to cause orientation spreads in the depth of the dispersion medium far beyond a distance of the order of molecular dimensions. Diffuse solvated films at the surface of the colloids prevent coalescence (flocculation) of the latter, and enhance the stability of the disperse system.

(2) *Volume Solvation* — "The osmotic penetration of solvent inside the micelles and immobilization of part of the solvent by the disperse phase."

Could these not explain the case of oil and the paraffins contained in it? Santi Ranjan Palit[15] suggests that gelation may be due to the mutual coalescence of the "solvation layer" made up of solvent, due to characteristic association tendencies, and that a higher proportion of solvent tends to prevent mutual coalescence between the neighboring "solvation layer" resulting in lower viscosity; that is, the gel has been dissolved by the addition of more solvent.

It is well known that the gradual addition of methanol to a solution of cellulose acetone precipitates the cellulose acetate. The addition of methanol dilutes the acetone and as a result some of the acetone molecules clinging to the surface of a solute particle (cellulose acetate) are replaced by methanol. After a time a point is reached where there are not sufficient acetone molecules adsorbed on the surface of the particles (solute) to keep them in suspension. The cellulose acetate molecules coagulate and precipitate. This may be brought about after the addition of only a very small percentage of the second solvent.

An analogy may be drawn between this and the effect of pour point depressant additives. Pour point depressant additives act like methanol, the oil like acetone and the wax like cellulose acetate. Just why such small amounts of additive should replace the oil, which is present in such large quantities adsorbed on the surface crystals, is difficult to explain.

Perhaps it could be explained by "selective" solvation due to similar orientation of the pour point depressant additive and the wax crystals. It is known that molecules even in liquids tend to orient themselves in much the same way as in the rigid lattices of crystals. A similarity of orientation forces may indicate the preference of paraffin particles for Paraflow instead of for oil.

Another disadvantage of this solvation theory, as well as one of the other theories reviewed, is that it does not readily give a possible explanation for the "wearing out" of Paraflow and other pour point depressants. It has been found that a blend containing Paraflow, warmed and cooled alternately for a great number of times, no longer has a low pour point. It may be that the active portion of Paraflow undergoes a chemical change such as oxidation under this treatment, in which case it would no longer be the same compound, and in reference to the orientation theory, would have different orientation tendencies.

The validity of these proposed theories could be investigated by a study of the effect of Paraflow on wax dissolved in other than oil solvents which are known to have solvation effects.

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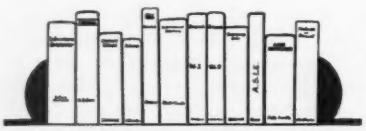

REVIEWS OF CURRENT BOOKS

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By H. Bennett, *Editor-in-Chief*, Chemical Publishing Company, Inc. Brooklyn, New York—1945. 475 pages—Price, $6.00.

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Those familiar with the previous volumes of this book know that detailed formulations of various chemical products are given, along with descriptions of processes of manufacture or production. The Editor does a remarkably complete job in assembling this great mass of varied useful information.

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—B. H. JENNINGS,
Editor.

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By Jack DeMent and H. G. Dake. Chemical Publishing Co., Inc., Brooklyn, N. Y. Second Edition, 343 pages. $4.00.

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The style of the book has been influenced by the authors' healthy enthusiasm. They state, "We have purposely included material of a controversial and thought-provoking nature . . . we are indeed aware of the numerous and exceptionally argumentative aspects characteristic of our subject." These conditions will naturally result in an unusual book.

(*Continued on page* 22)

Disc Viscometer

By R. F. McKIBBEN
The National Cash Register Company

ABSTRACT

A viscometer composed of two flat disces facing each other is described.

The instrument has been named a Disc Viscometer. The instrument may be used to measure the viscosity of samples as small as two milligrams. The Disc Viscometer will measure viscosities as low as 150 S.U.S. and as high as 500,000 S.U.S. Viscosities obtained with the instrument described agree within 10% of known viscosities.

* * * * * * * *

ONE of the major problems in the lubrication of cash registers and accounting machines is obtaining a material which will not change appreciably in consistency over long periods of time. Accordingly, part of the examination of materials for this purpose consisted of exposing a thin film of the material to circulating air at 158 F, and comparing the "feel" of the material with that of the original. The material was reported "gummy" or "non-gummy" depending on the judgment of the chemist. There was no method of giving a quantitative figure representing the nature of the material.

The sample was so small that any known methods of measuring consistency were inapplicable. Therefore, an instrument was developed for measuring the consistency of samples as small as two milligrams. The instrument has been named a Disc Viscometer.

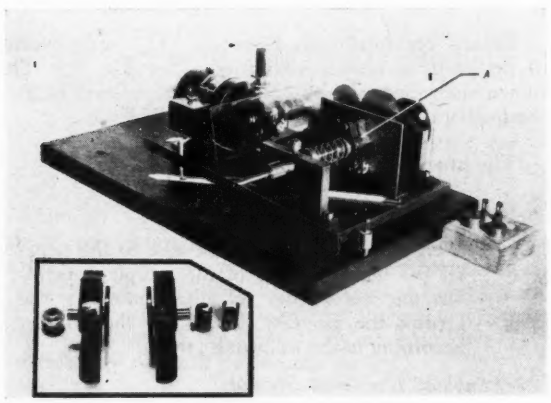

Figure 1. Disc Viscometer.
(Part A shown enlarged at lower left.)

The Disc Viscometer consists of two flat discs arranged so that one may be driven at any desired speed between 2 and 18 revolutions per minute. A small variable speed motor is used in conjunction with a gear chain to drive the disc. The second disc is mounted facing the driven disc and is attached to a shaft which carries an arm graduated in centimeters. The discs are mounted so that a spring may be placed against the mounting of the one attached to the shaft, pressing it against the driven disc. (See Fig. 1.)

The discs must be flat and smooth so that there is no irregularity present larger than the film thickness. The discs used in this work were finished to 1.5 microinches and to a flatness of 3 Newton's rings.

If a film of viscous material is placed between the discs, a torque will be transmitted from the driven disc, through the material and to the other disc. This torque may be measured by placing a weight on the arm in such a position that it balances the torque transmitted. The weight in grams, times the arm distance is the torque in gram centimeters.

Initially it was planned to compare the torque exerted by different samples. However, it was found that the viscosity of the material could be obtained in conventional units, from the torque, the thickness of the film and the dimensions of the instrument.

Daugherty[1] gives the equation

$$F = \mu \frac{AV}{y} \qquad (1)$$

where μ = the coefficient of viscosity
V = velocity
A = area
y = thickness of film
and F = force

The following derivation is based on Equation (1).

The force exerted on any portion of the disc (dA) by the lubricant film may be designated as dF and defined as

$$dF = \mu \frac{V\ dA}{y} \qquad (2)$$

but

$$dA = r\ dr\ d\theta \qquad \text{(see Fig. 3)}$$

where r = the radius at any point
R = the radius of the disc
θ = the angle between two radii

then

$$dF = \frac{\mu\ V\ r\ dr\ d\theta}{y} \qquad (3)$$

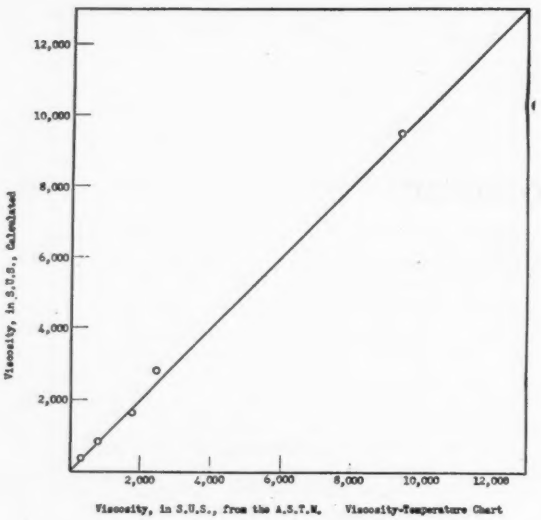

Figure 2. Calibration Chart.

V as the linear velocity may be defined as ω r, where ω = angular velocity in radians per unit time.

Equation (3) then becomes

$$dF = \frac{\omega\ r^2\ d\theta\ dr}{y}\ \mu \qquad (4)$$

The torque created by dF would equal

$$dt = r\ dF = \frac{\mu\ \omega\ r^3\ dr\ d\theta}{y} \qquad (5)$$

Integrating to obtain the torque, t, delivered through the entire film

$$t = \frac{\mu\ \omega}{y} \int_0^{2\pi} \int_0^{R} r^3\ dr\ d\theta \qquad (6)$$

$$t = \frac{\mu\ \omega\ R^4\ \pi}{2\ y} \qquad (7)$$

Rearranging Equation (7)

$$\mu = \frac{2\ y\ t}{\omega\ R^4\ \pi} \qquad (8)$$

In the Disc Viscometer used in this work

$R = 1.587$

$y = \frac{W}{\rho\ A}$

ρ = density of material

ω = revolutions per second x $2\ \pi$

W = weight of sample in grams

$A = \pi\ R^2 = 7.902$ square centimeters

t = torque in gram-centimeters

Since the force is measured in grams on the instrument but used in viscosity calculations as dynes, the gravity constant, (g = 980 cm per sec^2) must enter the equation: thus, Equation (8) becomes

$$\mu = \frac{2\ \omega\ t\ 980}{\rho\ 7.902\ 2\pi^2\ rps\ 1.587^4} \qquad (9)$$

After combining constants Equation (9) becomes

$$\mu = \frac{1.986\ W\ t}{\rho\ rps}\ poises \qquad (10)$$

Converting to centistokes

$$\mu = \frac{198.6\ W\ t}{\rho^2\ rps}\ centistokes \qquad (11)$$

Where the angular velocity of the driven disc is 0.1 rps and the density of the material is 0.9 (a density of 0.9 is used for all petroleum oils), converting to S.U.S. Equation (11) becomes

$$\mu = 11.33\ W\ t \qquad (12)$$

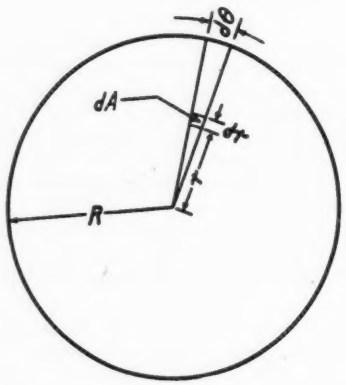

Figure 3.

Results obtained with Equation (12) agree within 10 per cent of known viscosities. (See Fig. 2.) The known viscosities were obtained by extrapolation of data obtained according to ASTM D 445-42T.

The procedure as developed is as follows:

1. Clean the disc
2. Weigh the sample onto the disc to the nearset 0.1 mg. The size of the sample depends on the consistency of the material; the greater the viscosity, the larger the sample, according to the following table:

Saybolt Universal Seconds	*Mg.*
Up to 1,000	2.3±0.1
1,000— 3,000	3.0±0.2
3,000— 5,000	4.2±0.2
5,000— 10,000	5.5±0.3
10,000— 20,000	7.0±0.3
20,000— 50,000	8.5±0.5
50,000—100,000	15.0±1.0
100,000—500,000	30.0±2.0

Difficulty in spreading the sample is encountered if smaller sample sizes are used, and leakage is encountered if larger samples are used. The close tolerance on sample size is not necessary on liquid materials but is very important on plastic materials such as petrolatums, greases, or inks where the rate of shear effects the viscosity.

The above table was prepared for petroleum products having specific gravities of approximately 0.9. For materials having specific gravities varying widely from 0.9, the sample size should be varied in direct proportion with the specific gravity. This also provides for a constant rate of shear in any given range of viscosity.

3. Place the sample and disc in the instrument facing the clean drive disc and connect couplings.
4. Adjust the disc speed to 6 rpm.
5. Place spring between tenon and housing of sample disc. Adjust tension to suitably spread the sample.
6. When sample is completely spread, as indicated by material appearing at the edge of discs, release the spring tension.
7. Measure the torque delivered through the sample film by adjusting weight on arm attached to shaft until arm is just forced down, noting weight and arm length. Again adjust weight until arm is just allowed to rise, noting arm length. Record the weight used and the average of the two arm length readings. In case of plastic materials, at times the sample does not break down immediately and there will be a slight decrease in torque after the material is completely spread. In such cases, record the reading after it remains constant for two minutes.
8. Record the temperature of the room at a position near the viscometer. The room in which this instrument is used has a temperature of 80 F ±2 F except for a short time in the summer when outside temperatures rise above that.
9. Calculate the viscosity according to Equation (12,) or Equation (11) corrected for variation in specific gravity.

Although this instrument was initially designed to evaluate the gumming tendency of lubricants, its use has been extended to measuring the consistency of a wide variety of materials. The very small samples which may be used on the Disc Viscometer allows a quantitative evaluation of the consistency of samples taken from bearings or small reservoirs.

Acknowledgment

The author wishes to express his appreciation for the interest and support of this work shown by Messrs. L. J. Hibbert and B. C. Morris of the Materials Laboratory of the National Cash Register Company; for the laboratory work done by Lawrence Swabb and Kieth Nash; and building of the instrument by the Register Proving Department.

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[1]Daugherty, R. L., *Hydraulics*, 4th edition, p. 4, New York, McGraw-Hill Book Co., 1937.

Directors of A.S.L.E. Meet

A meeting of the Board of Directors and the Officers of the Society was held January 7th at the Union League Club in Chicago.

Perhaps the most important item of business discussed at the meeting concerned a change in the regulations governing membership in the Society. The main gist of this regulation is the abolishment of the grade of Associate Member. The By-Laws of the Society, as now amended, read as follows:

REWORDING OF ARTICLE IV, SECTION 2 OF THE BY-LAWS

Section 2. Classes of Members. **The membership shall be divided into classes as follows:**

A. Members **shall be: (1) persons not less than twenty-four years in age who are engaged in research and instruction at technical schools, universities and various publicly and privately supported institutions in the field of lubrication; or (2) persons not less than twenty-four years of age who have occupied recognized positions as Lubrication Engineers for a period of three or more (not necessarily consecutive) years prior to date of admission, involving the responsibility for or supervision of the development, selection, field use and application of lubricants as differentiated from other activities; or (3) persons not less than twenty-four years in age who are indirectly concerned with the field of lubrication, but possessing other qualifications of experience, knowledge and accomplishment, have manifested a particular interest in the purposes and welfare of the Society, to the extent that their membership would be a valuable contribution to the successful functioning of its activities.**

B. Junior Members **shall be: persons less than twenty-four years in age, and those who do not completely fulfill the membership requirements of part *A*.**

C. Honorary Members **shall be: persons who have distinguished themselves in industry or science by outstanding contributions to the practical development and application or the theoretical basis of any branch of the field of lubrication. Honorary members shall not be subject to any other provision of this Article with respect to qualification for admission, but such memberships shall be conferred by the Society only in cases of unusual merit and achievement on the part of the recipient. Honorary memberships shall be conferred by the Society only upon recommendation by the Committee on Awards and review and confirmation of such recommendation as set forth in Section *3 B* of Article *VIII* of these by-laws.**

D. Sustaining Members **shall be: such persons or organizations as may be interested in and desire to contribute regularly to the support of the purposes and activities of the Society.**

Article VII of the By-Laws, entitled *Officers,* reads:

Section 10. Qualifications of Officers and Directors of the Society. **Every national officer or director of the Society must be a member of the Society and have qualifications which meet the specifications of Article *IV, Section 2 A*, parts (1) or (2).**

The other items of significant business concerned a discussion of the new Officers which, under the By-Laws, are elected by the Directors, and a Director's Committee to consider possible candidates was appointed. It was unanimously passed that the present Officers retain their authority until the Spring Convention.

The rest of the meeting was taken up with a discussion of detailed plans for the Spring Convention. The Program of the Convention is listed elsewhere in this issue.

B. H. JENNINGS.

Field Experiences with Heavy Duty Oils*

By WILLIAM H. BEAN

Surface Transportation Corporation

This article relates difficulties experienced in keeping Diesels running in transportation service, and the manner in which these have been met and overcome by improvements in lubricating oils. Today, the author states, oil development is ahead of engine development. Some cogent suggesions for engine improvement are set forth.

* * * * *

THE difficulties of lubricating high-speed, heavy-duty Diesel engines back in the early days, not so long ago, remind me of the predicament of the army pilot intent upon landing on a fog-bound field. The conversation went something like this:

"Pilot to control tower: Approaching field at 1000 feet. Over."

"Control tower to pilot: Ceiling zero. Circle field. Over."

Long pause. Then: "Pilot to control tower: Running out of gas. What shall I do?"

"Control tower to pilot: Repeat after me, 'Our father, Who art in Heaven . . .'."

That was about the way those of us felt who were having to operate Diesel engines of the heavy duty, high speed, high temperature class.

Prior to 1940, after three years' experience with a few Diesel-engined buses, we had been having all sorts of difficulties. Sludge formed in great quantities, filter elements clogged after very few miles, but worst of all, compression rings were sticking and oil rings became clogged.

It looked to some of us as if the only way to keep these buses on the road for any length of time was to heat up the engine (or take it right after going out of service), yank out the nozzles, and while still hot inject an ounce of chlorinated liquid into the top of the piston head. This had to be done at least every 4000 miles of operation. We had tried various additives then on the market in the oil and also in the fuel with no great success. The only thing that seemed really to help Diesel engines running was the hot injection on the piston head. This was difficult and troublesome, since the high pressure fuel lines had to be broken as well as the fuel return lines.

It became necessary in these early days to decide what oil would work best under the severe operating conditions encountered. These conditions included carrying heavy loads, and making frequent stops and starts (about 10 per mile), with the engine running at idle speed about 50% of the time.

To help us make this decision as to what oils could be used, we consulted with the engineers of many oil companies. And at one time early in 1940 we held a meeting which about a dozen engineers from the various oil companies attended. At this meeting the procedure for testing was adopted. I shall attempt to describe this procedure briefly by showing the forms used during the testing of the oils.

Figures 1, 2, and 3, show the dynamometer run-in procedure, and indicate the care with which engines were selected for testing the oils.

Figures 4, 5, and 6, indicate the method of making a report on the engine after it had been run several thousand miles in a vehicle. The lubricating oils were rated on the conditions found in the engine after a minimum of 8000 miles of running. If the oil succeeded in passing this first inspection, subsequent checks were made at 16,000, 33,000, and some went beyond 70,000 miles before the final check was made.

Over a period of five years from 1940 to date, nineteen different oil companies supplied us with 23 different brands of oil for test. Six oils tested could be classed as straight mineral oils, six as corrosion-oxidation inhibited, and eleven oils had the anti-corrosion-oxidation feature plus a detergent.

Two straight mineral oils at the 8000-mile check period showed up very well. Both were naphthenic oils. At 16,000 miles, though, these oils showed a decided downward trend, and failed before 33,000 miles of operation. These oils had been on the market for some years prior to 1940 and were excellent for their class, but for heavy duty Diesel operation they lacked the ability to keep the engines operating without the help of periodically injected solvents in the combustion chamber.

Out of the six corrosion and oxidation inhibiting oils, one oil stood out. It was a high viscosity index oil, and operated successfully for well over 35,000 miles. The compression oil rings kept free. However, the oil ring slots were filled with a hard varnish-type sludge and the piston skirts showed heavy varnish on all sides. It became clear that neither the straight mineral oils nor even

* *Presented before the New York Section of the A.S.L.E.*

DYNAMOMETER RUN-IN PROCEDURE SHEET A

Engine No. ..... Put in Bus ..... Brand of fuel used ..... Date .....

Injection Pump No. ..... Brand of lube oil used ..... Tester .....

Governor ..... Timer ..... Amount of lube oil used to charge engine, quarts .....

Work Done on Engine Overhaul: Connecting rod bearings ..... Main bearings ..... Pistons .....

Rings ..... Cylinder sleeves ..... Wrist Pins ..... Crankshaft .....

F HP's — NOZZLES REMOVED — DYNAMOMETER RUNNING AS A MOTOR

RPM	F Hp	Load at Arm R	Oil Pressure	Temperatures				Comments
				Water		Oil	Exhaust	
				In	Out			
At start of test—as soon as operating oil pressure is obtained.								
500								
After 30 minutes run (at 800 RPM).								
500								
1000								
After second 30 minutes run (at 1000 RPM).								
500								
1000								

Note— If last friction reading at 500 RPM is above 8.5 Hp. ntinue run and coreadings until Hp falls to 8.5, otherwise stop and check engine.

At the conclusion of the dynamometer lapping-in period, the engine will be stopped, the injection pump connected and the oil level in the crankcase and pump will be checked. If level is low, the amount added to the crankcase will be noted: Quarts added .....

DYNAMOMETER RUN-IN PROCEDURE (Continued) SHEET B

NOZZLES IN PLACE: ENGINE RUNNING AS A MOTOR, OPERATING DYNAMOMETER AS A GENERATOR. Date..... Tester.....
The engine will now be started and fuel oil line connections will be checked for leakage at pump and nozzles. Run for about 30 minutes with 25 Hp load at 800 RPM or until water outlet temperature reaches 100 F, and oil temperature reaches 145 F. At this point check for friction horsepower again at 500 RPM ..... and 1000 RPM ..... Make following runs and the required readings will be recorded at the end of the time periods:

RPM	Load	Load at Arm R	Time in Minutes	Oil Pressure	Temperatures, F.				F Hp	Comments
					Water		Oil Keep below 190F.	Exhaust		
					In	Out				
1000	20 B Hp		30						500 RPM	
									1000 RPM	
1200	40 B Hp		30							
1400	60 B Hp		60							
1600	25% Smoke-Max. fuel adjustment ..... B Hp		60							
1800	Maximum Fuel Adjustment ..... B Hp		60							

The governor will be set to cut off at 1950 RPM full load and the idle adjusted to 450 RPM:
Note the following at 450 RPM: OIL PRESSURE..... lb. OIL TEMPERATURE.....F.
Note the following at 1950 RPM: OIL PRESSURE..... lb. OIL TEMPERATURE.....F.

DYNAMOMETER RUN-IN PROCEDURE (Continued) SHEET C

NOZZLES IN PLACE — ENGINE RUNNING AS A MOTOR (Continued).
The engine will be adjusted at 1600 RPM for 25% smoke at maximum throttle postion with the water outlet temperature 180 F. and oil temperature at 180 F.
All brake horsepower readings on the final test will be made at maximum fuel adjustment.
Room temperature at start of test ..... At finish .....

RPM	BHP	Brake Load at Arm, R	Fuel Lbs. per B Hp Hr	Lb. Fuel Used	Time in Minutes	% Smoke	Oil Pressure	Temperatures				Brake Load at Arm, R	Calculated F Hp	Oil Temp.	Comment
								Water		Oil Keep Below 190	Exhaust				
								In	Out						
1800															
1600															
1400															
1200															
1000															
800															

Check for oil leak at rear main bearing .....
Note—Drain the used lube oil and record quantity .....

Page 1

REPORT OF LUBE OIL TEST

Date_____

Bus No._____ Name of Oil_____ Test No._____

Date test started _____
Date this inspection _____
Mileage since last inspection _____
Miles per quart this inspection _____
Total miles on test _____ Report No._____
Average miles per quart entire test _____

CONDITION OF ENGINE

Filter Elements_____

_____

Valve Covers_____

Rocker Arms_____

Cylinder Head_____

Crankcase Pan_____

Sump Screen_____

_____

COMMENTS:

Figure 4.

Page 2

CONDITION OF PISTONS, RINGS, CONN. ROD BEARINGS AND MEASUREMENTS

Location	#1	#2	#3	#4	#5	#6
Pistons (Upper Oil Holes (Lower						
Rings * Per cent is the amount of clogging in oil ring slot #1 Compression #2 " #3 " #4 " Top Oil Bottom "						
Bearings Connecting Rod Top Half Bottom Half						
Journals Conn.Rd Measurements						
Cylinder wear Measurements						
Nozzles						

Figure 5.

the inhibited oils were satisfactory for our heavy duty type of operation.

Then came the heavy duty oils. They began to come in volume. Except for one, no oil company after the middle of 1942 asked us to test an oil that was not both inhibited and detergent. Our tests on this type of oil had started as early as 1941. It is from this group of oils that we have obtained some very interesting and in some cases unusual results. Out of the eleven brands tested, the engines of six reached the 33,000 mile check with flying colors; five went over 40,000 without trouble. One went better than 70,000 and could have gone much further had we allowed it.

If this experience is representative, it goes to show that the larger percentage of the new heavy duty oils developed will be satisfactory for use in Diesel engines doing heavy work.

It is getting more and more difficult to judge comparative merits of heavy duty oils on our test basis

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(Date & Month) (Year)

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Form N 211

ENGINE INSPECTION REPORT

LOCATION _____ DATE _____

ENGINE BLOCK No. _____

CYLINDER OR SLEEVE DIMENSIONS AND WEAR

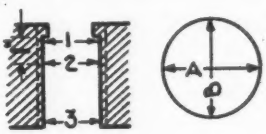
MICROMETER MEASUREMENTS	CYL. No. 1		CYL. No. 2		CYL. No. 3		CYL. No. 4		CYL. No. 5		CYL. No. 6	
	A	B	A	B	A	B	A	B	A	B	A	B
1—JUST BELOW RIDGE.												
2—ONE INCH BELOW RIDGE.												
DIFFERENCE BETWEEN 1 & 2												
3—AT BOTTOM OF BORE.												
DIFFERENCE BETWEEN 2 & 3.												
4—ORIGINAL BORE (If Available).												
DIFFERENCE BETWEEN 3 & 4.												
TOTAL WEAR.												

CONDITION: ROD BEARINGS: _____

CONDITION: MAIN BEARINGS: _____

CONDITION: VALVES: _____

OTHER CONDITIONS FOUND: _____



INSPECTED BY: _____

TOTAL ENGINE MILEAGE: _____ TOTAL SLEEVE MILEAGE: _____

WAS ENGINE REBORED? _____ DIAMETER: _____

WAS ENGINE RESLEEVED? _____ DIAMETER: _____

MAKE OF SLEEVE: _____

COMPLETED BY: _____

Figure 6.

since the difference is becoming less and less between them. In 1940 at 8000 miles one could easily tell by looking at the pistons what was happening and about how soon the rings would be stuck. A quick glance at the bearings and one just about knew what was what. Now to make completely comparative tests one should weigh bearings, check cylinder wear measurements carefully, and run the engine for 50,000 miles in service, making periodic checks. Most fleet operators require well over a year to attain this mileage. Then one can begin to get a picture which will permit rating of one oil against another.

An outstanding job has been done by oil men to overcome the defects which are still prevalent in commercial engines in general use. As a matter of fact, if engines manufacturers had put as much development into their engine building as oil engineers have put into their oil building, the oil engineer's lot would have been a happier one. Right now the oil engineer is a jump ahead of most engine builders in technological advances.

The one big problem that has yet to be overcome seems really to be more in the realm of engine design than under the control of oil engineers. That is what to do about the cold sludge type of operation. Heavy duty oils are not the complete answer. The answer, I believe, is heat flow — proper operating temperatures in all parts of the engine. Where improper heat flow in the high-output engine glaringly shows itself in localized hot spots, engines in light service suffer and die from localized cold spots. Oil engineers through their heavy duty oils have found a way to lick the hot spot troubles. The cold spot troubles remain very much with us.

We know the human body requires an operating temperature of 98.6F summer and winter, Eskimo or South Sea Islander; and one suffers if the body temperature varies one degree plus or minus. We take care to use the necessary means to preserve this body temperature. In the tropics, I am told, only mad dogs and Englishmen go out in the noonday sun. In winter climates one couldn't go around very long with just one's pants on and bare from the waist up, or vice versa. With an engine it's usually vice versa. Why aren't we as sensible with our engines as we are with our bodies?

Generally it takes about a half hour of regular driving before water temperature rises to a point where it levels off. It takes about two hours of driving before the oil temperature does the same. Why should it take so long? Poor circulation, not enough hot water in the right places to maintain a uniform temperature of both oil and water?

When we race the engine to warm it, the engine fan goes hell-bent to cool it. On a bus equipped with a bellows type thermostat and shutters I experienced difficulty getting the engine water temperature above 120F when the weather man was

handing out zero weather. But when the engine had the cooling fan removed, the water was boiling in less than twenty minutes. Therefore one can conclude that the fan is a positive means of control for water temperature. I have been unable to obtain the variable pitch type of fan for test, but I am testing a type that turns when the engine temperature calls for cooling and remains motionless if the engine is cold. This type is very simple, with few parts, and shows great promise.

With the controlled fan we can get and keep the water temperature where we want it and in a hurry. If we have control of water temperature, why can't we control oil temperature? If we put our minds to it, we very easily can. I think most automotive engineers agree that the ideal crankcase oil temperature is the same as the water temperature—somewhere around 180F. There are a number of ways to do the job. Just build into the engine enough water-jacketed surface to get heat to flow. It will flow from water to oil when the engine is cold, just starting up; and when the engine is hot the flow of heat will reverse and the hot oil will be cooled by the water; and all cooling will be controlled by a fan that knows when to fan and when not to. Parts of the oil pan where water cooling is not feasible might have a blanket insulation.

One leading oil company recently published in its monthly magazine[1] an article that sheds considerable light on this low-temperature sludge problem. The effect of operating at the optimum oil temperatures is highly significant. If the crankcase oil is held at 180F, the amount of sludge deposited on oil rings, oil pan and cover plates is about half the amount deposited at the lower temperatures normally found. If jacket temperatures are held at the same 180F figure, the deposit on piston skirts is only half what it normally is; on oil rings it is about a third, and on oil pan and cover plates it is little more than a fourth. These figures bear out my conviction that it will be very desirable to work for improved temperature conditions as the most effective means of overcoming the cold sludge problem. Don't tell me that it would be costly to control engine temperature; it is costlier not to.

Of course there are other ways to do it. One sure way of practically eliminating sludge and engine deposits is to change oil every 100 miles or so. But this would be like seeing your doctor once a week and having him give you a blood transfusion. It isn't necessary unless you abuse your system, and are unable to throw off the accumulated poisons in the more natural way. To my mind, for a healthy lubricating system, temperature control is the nature's way, and I don't have to spell it backwards.

Though I realize that the whole question of the control of engine temperatures is a matter for the engine builder to overcome, your influence can be powerful. A little properly-directed agitation from your association as a whole might lead to your acting as the engine builders' consultant before rather than after the fact.

In the meantime, though, until this ideal condition comes into being, we must go on as best we can, and by constant watchfulness keep our troubles to a minimum. We must operate our present vehicles as they have been built for us. And in so doing let me mention right here a very effective way to keep track of what is going on in a fleet of vehicles. Get a suction pump about the size of an overgrown hypodermic needle, and extract an ounce or two of oil from each of your engines periodically, and make a few simple checks. You will be able to determine a number of interesting things about your engines and what is happening to them.

If you check these samples for dilution, metal, water, gums, dirt, free carbon, fuel soot, and so on, you will get a pretty good picture of the fleet's condition. You can anticipate trouble before it becomes serious. Take dilution, for example: With one popular make of Diesel engine having the unit type of injector, crankcase dilution is frequently experienced. By regular oil sampling one can easily detect an offending engine. There are two conditions that produce dilution: (1), a bad injector nozzle, and (2), a loose injector line. If it's a bad injector nozzle the fuel mileage will show up poor. If the mileage is all right you can bet it's a loose line. A lot of information can be obtained with such periodic sampling.

Our experience with heavy duty oils, then, has been that only a few years ago several apparently insoluble problems confronted us who operate fleets and those who provide the lubricants. Most of those problems have now been solved. Types of oil have been developed that furnish satisfactory lubrication under severe conditions. By stabilizing oils and adding detergency properties bearing corrosion has been reduced and the formation of hot engine sludge deposits minimized.

Considering all the work that has been done on heavy duty oil and the success so far, it may be that I need not be so concerned over the one big problem remaining to be done—the problem of conquering the cold sludge evil. As it is now, with the home-made means of temperature control — the make-shift methods that we have had to devise, fleet operators have been only moderately successful. We have had to adapt these home-made measures to our type of operation, whether it be long haul, or short frequent-stop type of service.

Maybe some of the researchers that have been laboring over this cold sludge problem are 'way ahead of me and have developed an oil that will handle it, an oil that will solve *all* our problems, hot, cold, labor and management included. But until the announcement of such a triumph, we'll have to settle for an oil that keeps the rings, pistons, oil pan and cover plates clean without causing the bearings to fall apart; and we'll have to keep on working to achieve an adequate system of temperature control as the only means to overcome cold sludge.

[1] *The Texas Company. Nov., 1945, issue of "Lubrication."*

Book Reviews

(*Continued from page* 14)

We find interspersed among the numerous and valuable tables and charts (none of them numbered), prose varying from what is apparently a series of direct quotations from file cards to literary gems of high quality. Serious students being introduced to uranium chemistry will appreciate the numerous references throughout the text, at the end of chapters, and in the bibliography. The reviewer believes the authors have tried and succeeded in writing a useful introduction to uranium chemistry. The inclusion of "atomic power" in the title is unfortunate since it gives the erroneous impression that the nuclear physics of uranium is given appreciable consideration.

F. C. W. Olson,
Northwestern University.

Potentiometric Determination of Acidity and Basicity In New and Used Petroleum Lubricants

PART I

By LOUIS LYKKEN

Shell Development Company, Emeryville, California

Abstract

Potentiometric methods for the determination of free and combined acidity have been found to be particularly applicable to highly colored or opaque materials such as used lubricants and lubricants containing oxidation and corrosion inhibitors, detergents, fats, and other additives, where acidimetric color indicator titrations fail. Although developed primarily for study of the oxidation characteristics of lubricating oils, the principles, apparatus, and procedures are applicable to many other materials such as asphalt, emulsions, resins, polymers, animal and vegetable fats, oils, and related materials.

Titration is made either directly or after saponification with potassium hydroxide in a single phase solution of the sample in nonaqueous solvent (benzene-isopropyl alcohol containing approximately 0.5% water) using a glass-calomel electrode system. Inflection points and fixed cell potentials are used to determine the end points.

* * * * * * * *

Introduction

THE use of neutralization numbers and saponification numbers for the evaluation of new and used lubricants is well known. Definite relationships have been found to exist between the acidity and the so-called "existent corrosivity"[6] of an oil; also, the saponification number has been shown to represent 30% of the oxygen consumed by a lubricant during oxidation tests and has become useful as a criterion of the degree of deterioration of an oil.[4] However, in spite of the widespread application of these tests, their value and usefulness has been greatly limited by the inadequacy of the usual color-indicator titration methods. Many attempts have been made to devise suitable color-indicator methods for the determination of acids and bases in colored or opaque oils, but these methods have met with little success. If such a titration is carried out in a single phase solution of the oil in a nonaqueous solvent, the dark color of the oil interferes with, or masks entirely, the indicator color change at the end point. Furthermore, because such materials frequently contain not just one or two acids or bases, but often contain a large number of different components having slightly different acid or base strengths (degrees of ionization), the indicator color change, even when visible, is not clear and sharp but is gradual, often fading due to the slowness of the reaction of the titrant with the sample. In addition, the behavior of the indicator in the nonaqueous solvent may be quite different from its behavior in aqueous solutions, necessitating careful study of its characteristics before it can be used indiscriminantly in nonaqueous solutions.

A consideration of the disadvantages of a single-phase, color-indicator titration suggests the possibility of carrying out a two-phase titration, where the dark-colored oil is confined to a solvent layer while the acidic or basic constituents are extracted into an aqueous layer so that the dark color of the oil can not interfere with the visibility of the end point. There are many such methods, the most familiar being the ASTM tentative color-indicator method, ASTM Designation D663-44T. The fundamental defect of these methods lies in the fact that successful analysis depends upon the complete extraction of acidic (or basic) constituents from the oil phase to an aqueous phase. Completeness of extraction depends upon instant reaction of the acidic (or basic) constituents with the titration solution and upon good contact between the oil-solvent and aqueous layers; however, certain types of acidic or basic constituents, such as metallic salts and esters, often react slowly, contributing to the fading or the return of the indicator color upon standing. Good contact between the two layers can be obtained only by vigorous swirling and shaking; however, such treatment frequently causes the mixture to emulsify (particularly when the sample is an oxidized oil) and prevents ready observation of the end point. The poor precision commonly obtained by this method of titration is caused by a combination of these factors.

The superiority of a single-phase, equilibrium titration over a two-phase, extraction titration is immediately obvious. The difficulties encountered in the use of color-indicators can be avoided by carrying out the titration potentiometrically, the change in potential of a suitable electrode system during the titration serving to indicate the end point of the titration. Such a titration not only gives the amount of acidic or basic constituents present, but indicates their relative acid or base strengths (degree of ionization) and thus serves to help identify and classify the constituents of the sample.

A potentiometric method which is both sound in principle and readily applicable in practice should combine several important characteristics. The electrodes should be sturdy and should readily give reproducible values in identical solutions. They should not be attacked by dilute acid or base solutions or by organic materials, be subject to atmospheric oxidation, or appreciably contaminate the titration solvent. The potential difference of the electrode system should be nearly proportional to the hydrogen-ion activity (acid strength) of the mixture of titration solvent and sample, and equilibrium between solution and electrodes should be

attained in a conveniently short time. The titration solvent should completely dissolve an adequate amount of sample and this mixture should tolerate the presence of several per cent water from the sample without formation of a second phase. The titration medium should have a low inherent acid value and should be inert to prolonged action of strong bases, strong acids, salts, metals, glass, and atmospheric materials. The polar properties of the solvents should be such that dissolved, weak acidic materials (dissociation constants greater than 10^{-7} when dissolved in water) will ionize sufficiently to permit neutralization by the addition of an equivalent quantity of an alcoholic strong base solution. The titration solvent should be sufficiently conductive to allow only momentary accumulation of electrostatic charges when a low-resistance reference electrode is immersd in it.

Since no previously published method entirely fulfills these conditions, an extensive study of electrodes, solvents and meters was undertaken. This work resulted in the development of new potentiometric methods for the determination of free and combined acids and bases in either colored or colorless petroleum lubricants and related materials.[5] Although the details of these methods are readily available elsewhere,[1,3] brief synopses of them are given at the end of this paper for the information of those not familiar with them. However, it is necessary to consult the detailed procedures before applying the methods to actual samples.

Discussion of Method

The potentiometric method for either free or combined acids and bases involves titration of the sample in a benzene-isopropyl alcohol solvent containing 0.5 per cent water, the titrant being alcoholic acid or base, using a high-resistance glass indicating electrode and calomel reference electrode. The end points are indicated by inflections in the potential-volume curve or, when no definite inflection occurs, by fixed cell potentials. In the determination of combined acids and bases, the sample is first saponified by refluxing with an excess of potassium hydroxide.

The general applicability and usefulness of the potentiometric methods have been demonstrated during the last five years by successful application to the determination of free and combined acidity in new and used engine oils, oxidized oils, turbine oils, oil additives, motor oil sludges, asphaltenes, crude oils, asphalt residues, distillates, distillate bottoms, polymers, rubber, soaps, vegetable and animal oils, fats, waxes, greases, common solvents, and water solutions. The samples must be soluble or nearly soluble in benzene-isopropyl alcohol solvent, and may be colorless, colored, or produce colored solutions during the determination. The methods are capable of rapid, routine application and the results obtained give useful information concerning the sample in addition to the free acid, free base and combined acid values.

The principles involved in the interpretation of nonaqueous potentiometric titration data are completely analogous to those applied to the interpretation of aqueous titration data. In a non aqueous titration as in aqueous titrations, the form of the titration curve and its plateau characteristics are dependent upon the strength of the acid or base titrated, sharp inflections generally appearing at the equivalence points. Figure 1 shows a collection of titration curves for a number of acids of varying acid strengths, illustrating the effect of acid strength upon the form of the resulting curve.

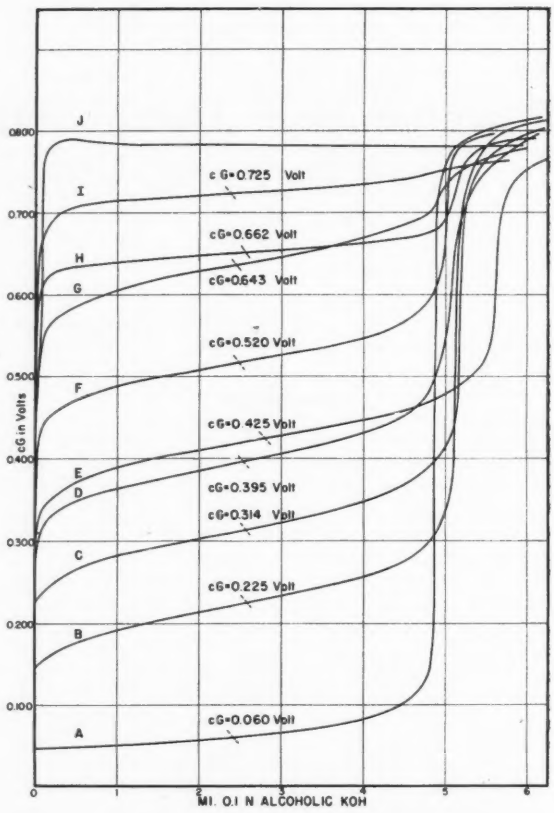


Figure 1. Influence of Acid Strength Upon the Free Acid Titration Curve.

Potentiometric Titration of Various Acids with Alcoholic Potassium Hydroxide:

A—Hydrochloric acid
B—Trichloroacetic acid
C—Dichloroacetic acid
D—Monochloroacetic acid
E—Formic acid
F—Acetic acid
G—m—Nitrophenol
H—p—Nitrophenol
I—Phenol (Hydroxybenzene)
J—Blank.

Titration Cell: Glass Electrode // Calomel Electrode.
Titration Sovent: 50 ml. Benzene, 50 ml. isopropyl alcohol Containing 1% water.

Similar relationships are true for bases titrated with hydrochloric acid.

Various acid or base groups may be distinguished, provided there is a satisfactory difference between the acid or base strengths of the groups to be determined. For instance, titration of a mixture containing hydrochloric acid, dichloro-acetic acid, acetic acid, and thiophenol gives a curve having four distinct inflections (Figure 2), each inflection occurring at the stoichiometric point for the respective acids in order of the diminishing degree of ionization. This separation or resolution of several acidic or basic materials differing appreciably in degree of dissociation is of considerable advantage since the amounts of highly corrosive, strong acids present in an oxidized engine oil can be determined by this means in the presence of any concentration of weaker less harmful acids. The possibility of distinguishing the strong acids from the weaker acids is especially good in nonaqueous media, since weak acids appear to have a lower degree of ionization in such media than in water, while strong acids appear to ionize to the same extent in either type of solvent. This

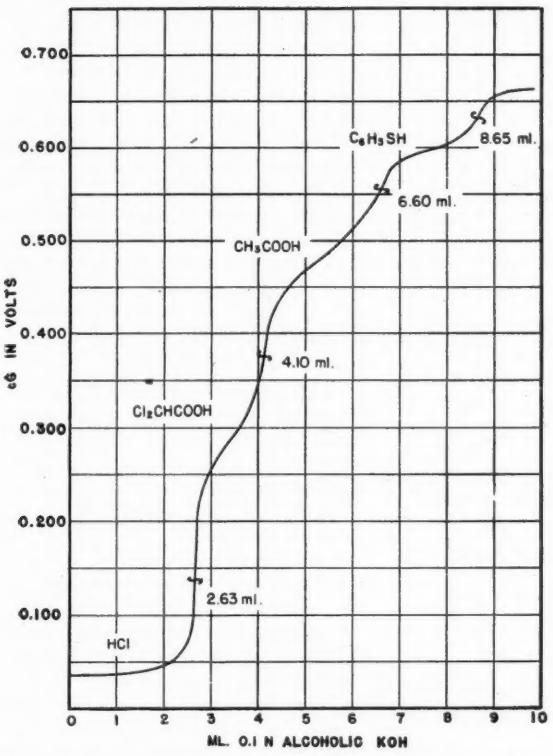


Figure 2. Successive Potentiometric Titration of Several Acids in Nonaqueous Medium.

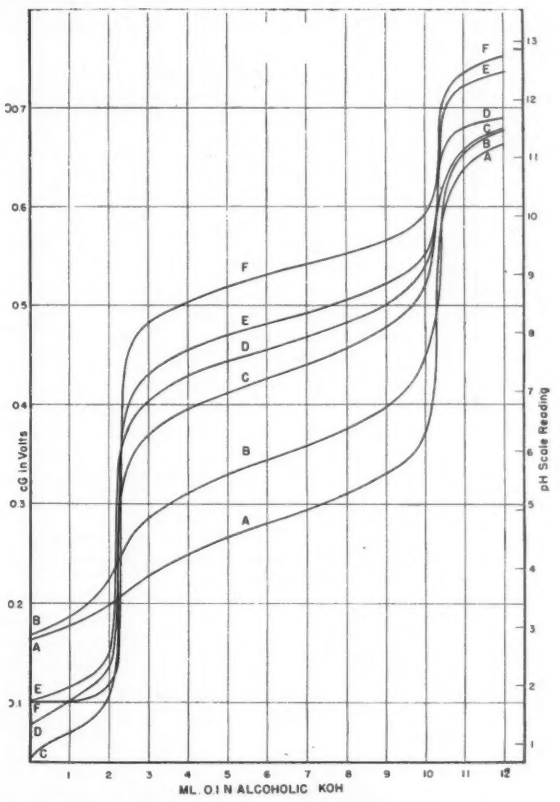


Figure 3. The effects of Nonaqueous Medium Characteristics Upon Free Acid Titration Curves.

Potentiometric Titration of Hydrochloric and Acetic Acids with Alcoholic Potassium Hydroxide in the Following Media:

A—125 ml. water
B— 62 ml. methanol, 62 ml. water
C—125 ml. methanol (0.5% water)
D—125 ml. ethanol (0.5% water)
E—125 ml. isopropyl alcohol (0.5% water)
F— 62 ml. benzene, 62 ml. isopropyl alcohol containing 1% water.

Titration Cell: Glass Electrode // Calomel Electrode.

enhanced resolution of different acids in nonaqueous media is illustrated by the series of titration curves shown in Figure 3. These curves represent titration of the same mixture of a strong and a weak acid in media which are successively less water-like, i. e., more nonaqueous, in character.

The applicability of the glass electrode to the measurement of hydrogen ion activity in nonaqueous solutions has been questioned from a theoretical viewpoint; however, titration curves made in nonaqueous solvents using the glass-calomel electrode pair are perfectly reproducible and are usable for accurate measurement of the acid or base content of the solutions. Furthermore, although the apparent acid strength of a given acid in nonaqueous solvents is usually different from that shown by the acid in water, a regular relationship has been found to exist[5] that makes possible identification of the acid from its nonaqueous titration data.

The marked difference between titration curves for the same acid in different media makes the term "pH" somewhat confusing for use with nonaqueous solvents. To eliminate this confusion and yet provide an index in terms of which the hydrogen ion activity of a nonaqueous solution may be expressed, a new relative acidity scale has been devised. This new scale, designating the corrected glass or cG scale, is based upon the assumption that the variation of the potential of the glass electrode with hydrogen ion activity in nonaqueous solution is completely analogous to that in water and, therefore, that the following equation can be assumed valid:

$$cG = E - E_{GC}$$

where:

E is the observed voltage of the titration cell immersed in the solvent, and

E_{GC} is a constant term for each electrode pair combining the assymetry potential of the glass electrode and the constant contact potential of the calomel electrode.

To provide a convenient means for evaluating the stant term E_{GC}, the voltage corresponding to cG=O is arbitrarily taken as the theoretical voltage reading of the electrodes in an aqueous solution of pH=O. This reference point is located by measuring the voltage of the electrodes when immersed in an aqueous buffer solution of known pH value and calculating the cG value as follows:

$$cG = 0.0591 \times \text{pH value}.$$

Practical application of the potentiometric methods result in titration curves such as those shown in Figures 4, 5, 6, and 7. Curve D of Figure 4 shows a curve obtained for a mixture of strong acid (hydrochloric) and weak acid (naphthenic acids). Comparison of curves C and D, Figure 4, with Figure 2 shows that naphthenic acid is somewhat weaker than acetic acid. Curve E of Figure 4 shows a sample containing base groups of three strengths: strong, moderately strong,

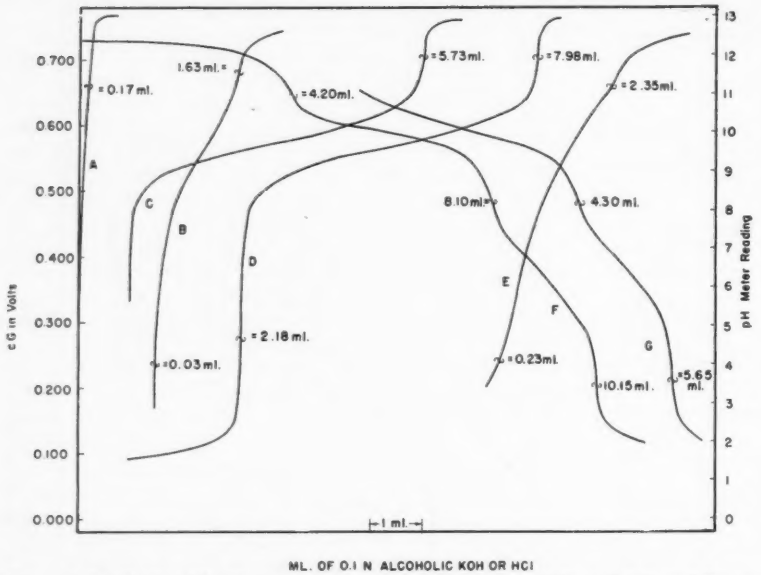


Figure 4. Illustrative Titration Curves for the Determination of Free Acids and Bases.
Potentiometric Titration with Base:
A—Blank
B—10g. Oxidized Oil
C—Naphthenic Acid
D—Hydrochloric and Naphthenic Acids
E—5g. Asphalt
Potentionmetric Titration with Acid:
F—5g. Alkaline Oil containing Free Caustic
G—5g. Alkaline Oil.
Titration Cell: Glass Electrode // Saturated Calomel Electrode
Titration Solvent: 50 ml. Benzene and 50 ml. Isopropyl Alcohol containing one per cent water.

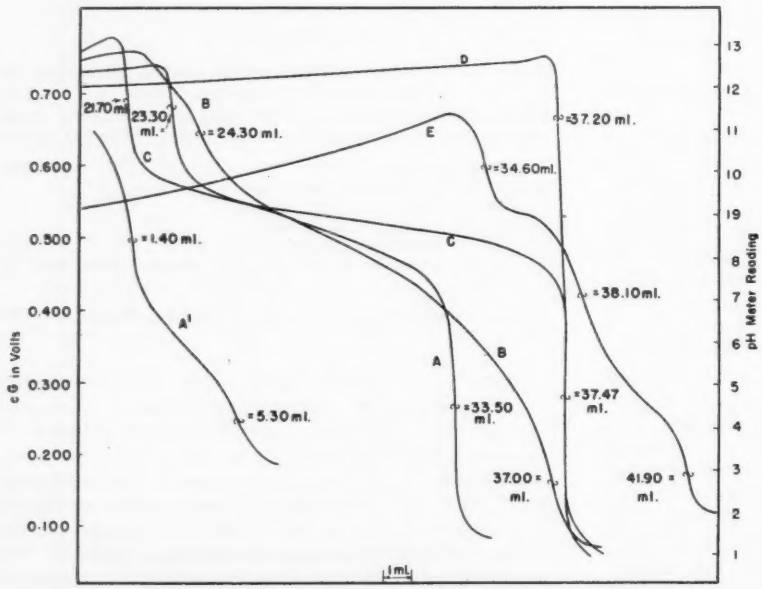


Figure 5. Illustrative Titration Curves for the Determination of Combined Acids and Bases.
Potentiometric Titration with Alcoholic Hydrochloric Acid of Basic Constituents Remaining after Saponification with Potassium Hydroxide:
A—Rapeseed Oil—Titration of nonaqueous saponification mixture.
A[1]—Rapeseed Oil—Titration of water soluble residues remaining in the saponification vessel
B—Oxidized Oil—Titration of nonaqueous saponification mixture directly in the reflux vessel
C—Castor Oil—Titration of nonaqueous saponification mixture directly in the reflux vessel
D—Blank—Titration of nonaqueous saponification mixture directly in the rebux vessel
E—Alkaline Oil—Titration of nonaqueous saponification mixture directly in the rebux vessel.
Titration Cell: Glass Electrode // Calomel Electrode
Saponification Medium: 50 ml. Benzene, 50 ml. isopropyl alcohol.

and weak. Curves B and E of Figure 4 are the type obtained when the sample is composed of a mixture of many acids of various strengths. Figure 5 shows typical curves for the determination of combined acids and bases. Figures 6 and 7 are typical results obtained for oxidation and use tests on samples withdrawn from engine crankcases as oxidation proceeds. Figure 6 and 7 are plotted in terms of mg. KOH/g. instead of ml. of titrant in order to facilitate comparison of the curves for different stages of oxidation.

The acidity or basicity present in oxidized oils is by no means necessarily due to a single acid or base. It is generally made up of a large number of different components, each having its own individual degree of ionization. As a result, in contrast to the clear curves produced by single acids or bases (Figure 1), the oxidized oils yield indefinite titration curves of the type illustrated by curves B and E of Figure 4, curve B of Figure 5 and all of the curves of Figures 6 and 7. In some cases there is an inflection in the curve to indicate the end point; however, in many instances the titration curves exhibit no recognizable inflection.

In such cases, in order to measure the changes in acidity or basicity taking place during the oxidation of the oil, it was necessary to establish definite cG reference points to be used to indicate the end point of the titration in much the same way that indicators are used for this purpose. For the purposes of the methods presented in this paper, the points cG =0.650 volt for total acid and cG= 0.236 volt for total base were chosen to represent the points indicating the transition to strong base and strong acid, respectively. These points were selected because, for all oxidized oil samples that give good inflections in the titration curves, the inflections occurred at or near these points.

The point cG=0.650 volt is also near the point at which phenolphthalein changes color in benzene-isopropyl alcohol solution. Of course, if a definite, recognizable inflection is realized in this range, the end point is logically chosen at this inflection. Many attempts were made to choose the end point at the insignificant break or "dip" occuring between cG=0.600 and 0.650 volts, which is often found with oxidized oils, but the resulting precision was found to be generally poor and erratic and, therefore, this practice was abandoned.

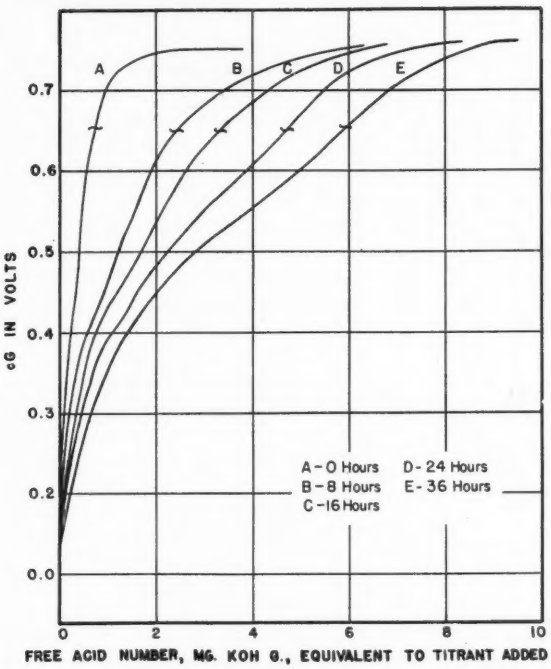


Figure 6. Typical Series of Curves Depicting Changes in Free Acid Numbers of Motor Oils at Various Stages of Oxidation.

Comparison of Potentiometric and Color-Indicator Results Obtained For Oxidized Engine Oils and Additives

During the investigation leading to the development of the potentiometric method, many attempts were made to apply color-indicator methods to the determination of acidity in dark petroleum products for the practical reason of economy in time and equipment. All indicators and mixed indicators recommended in the literature were tested; they were rejected because (1) the color change was not discernable in the very dark samples, (2) the color change took place too early or too late when compared with potentiometric titration results, or (3) the color change was found to be gradual or indistinct. Spotlights, ultraviolet lights to induce fluorescence, white porcelain surfaces pressed against the sides of the titration flask, and tilting of the flask were tried without success to obtain better observation of the end point.

During the extensive investigation of color-indicator methods, a large amount of data was obtained for comparison of the color-indicator results (ASTM D663) to potentiometric results. No usable relationship was found between acid numbers of dark oils obtained by the potentiometric method and those obtained by the usual color-indicator method.

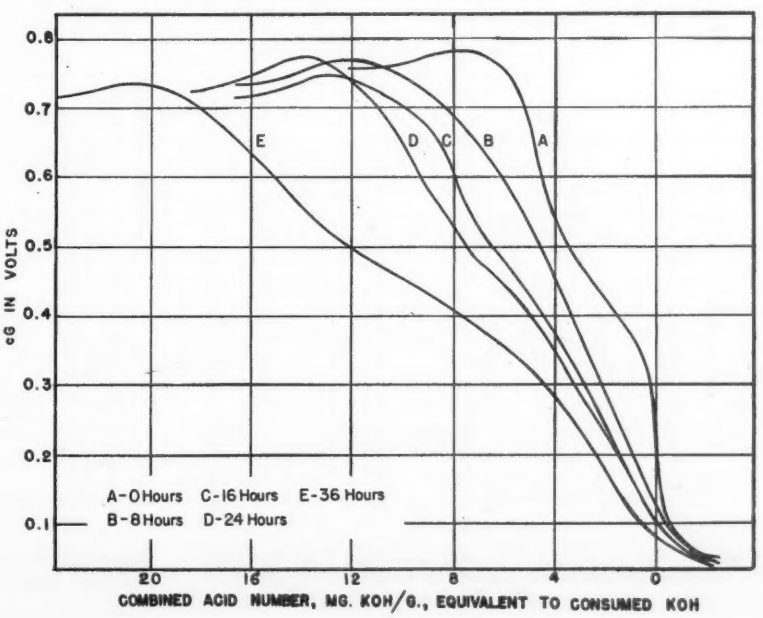


Figure 7. Typical Series of Curves Depicting Changes in Combined Acid Number of Motor Oils at Various Stages of Oxidation.

This is illustrated in Table I, which shows the acid number obtained for several typical series of oxidized oils chosen at random from the results of a large number of oil oxidation tests. For combined acid (saponification) number, the agreement between the results of color-indicator and potentiometric methods is somewhat better (Table II), probably because of the smaller sample size and more concentrated reagents used.

The results by the potentiometric method for free acid or base are invariably higher than the corresponding results by the color-indicator methods, and they are much less erratic for series of samples obtained from oxidation tests. In tests made including several of the most popular color-indicator methods, it was found that the potentiometric method is more reproducible in the hands of different operators and gives more consistent results.

Potentiometric acidity and basicity results, and especially combined acidity results, correlate well with other properties of oxidized oils undergoing tests. Figures 9, 10, and 11 give data from some representative tests picked at random from a large number of engine oxidation tests. It can be noticed that the saponification number is a sensitive criterion of the condition of the oil. In those cases for which the color-indicator results are given, it is evident that these results are less sensitive than the potentiometric results; in one case (Figure 8), which is typical in common practice, the color-indicator results depart from the trend, showing an opposite effect to that expected from other criteria of oxidation.

The use of special additives and detergents for improving the characteristics of lubricating oils has recently become general practice. These materials, the greater part of which have acidic or basic properties, generally complicate the determination of acidity by color-indicator methods now in use, but offer no obstacle to the potentiometric methods. Typical titration curves for such additives (Figure 11) show that their presence can cause an oil sample to have both an acid and a base number simultaneously, a condition which often leads to erroneous conclusions when using current color-indicator methods. When an oil containing a metallic additive is oxidized, the stronger acids formed

neutralize the basic constituents of the additive and the weak acids generally remain as free weak acids or form esters. The potentiometric method is inherently useful for determining the true condition of the sample since it is capable of distinguishing the weak acids formed from the stronger acids formed that have neutralized the additive; also it gives important information concerning the approximate acid strengths of the acids neutralized by the additive.

In the analysis of "doped" oils, the ability of the potentiometric method to distinguish between acids of different acid strengths is of special value. With such oils, high acid neutralization numbers are found where the oil is often entirely non-corrosive; however, using the potentiometric method, these acid values can be separated into two components, first, the more corrosive strong acidity and, second, the less harmful weak acidity principally contributed by the additive. Another advantage of the potentiometric method when applied to oils containing additives is its usefulness in identifying the additives present by the characteristic titration curves produced.

Apparatus

Electrode System

Of the various available indicating electrodes, the modern high-resistance glass electrode (Beckman Electrode No. 4990, manufactured by the National Technical Laboratories) has been found to be the most satisfactory. It requires adequate shielding in order to avoid error due to electrostatic influences and is not applicable in completely anhydrous solvents. As a reference electrode to use with the glass electrode, the saturated calomel electrode used with a suitable salt bridge has been found satisfactory (Beckman Electrode No.

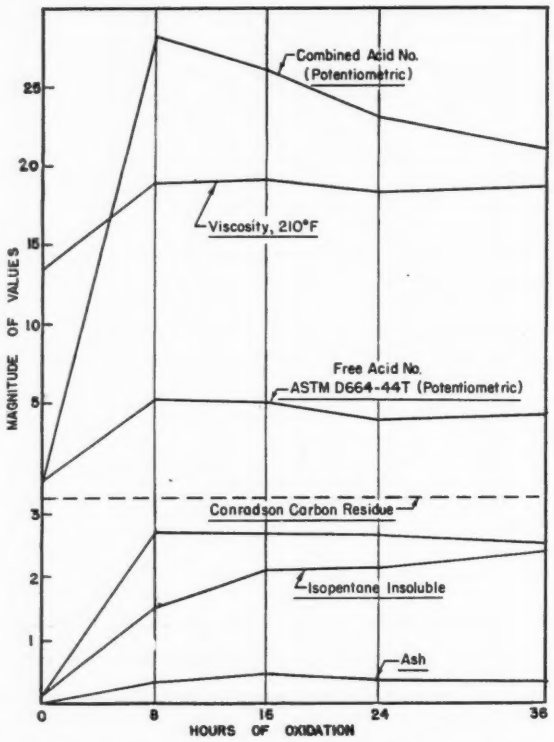


Figure 9. Relationship of Free and Combined Acid Numbers to Other Analytical Data Found for Progressively Oxidized Oil—Oil B.

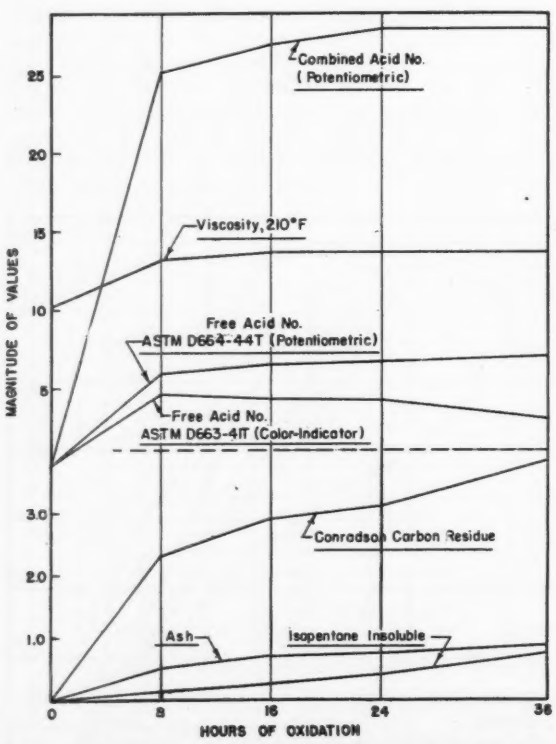


Figure 8. Relationship of Free and Combined Acid Numbers to Other Analytical Data Found for Progressively Oxidized Oil—Oil A.

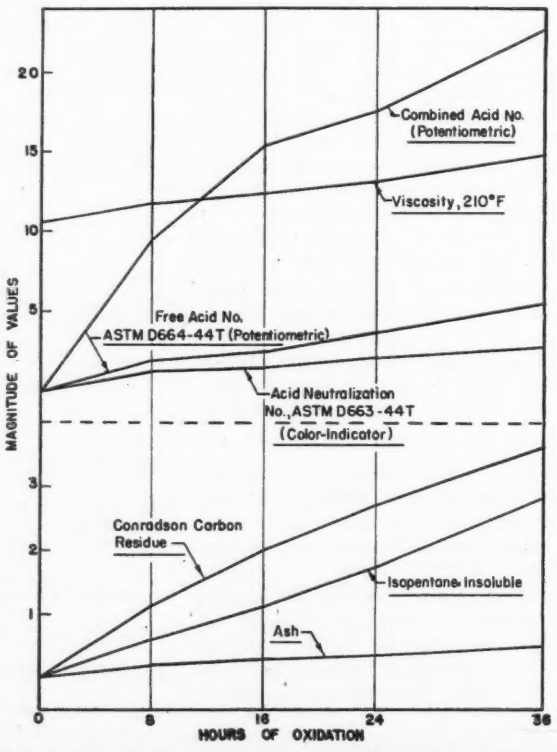


Figure 10. Relationship of Free and Combined Acid Numbers to Other Analytical Data Found for Progressively Oxidized Oil—Oil C.

4970A, manufactured by the National Technical Laboratories).

For consistently reproducible results, it is essential that the electrode system be systematically prepared before each titration and tested at regular intervals for defects and aging.[5] Improper preparation of the electrode system has generally shown the following manifestations in the blank titration on the titration solvent: (1) production of a totration curve that fails to exceed cG=0.700 volt upon addition of 0.5 to 1.0 ml. of standard base; (2) extremely slow rate of equilibration between increments of base; (3) little or no change in potential with the initial regular intervals to defects and agfor the titration curve to begin at too high cG potentials. In addition, improper electrode preparation

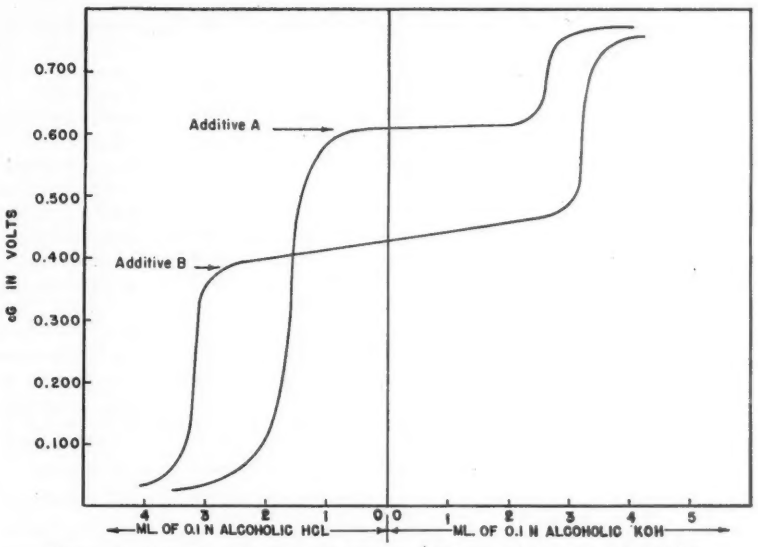


Figure 11. Titration Curves Obtained for Typical Lubricating Oil Additives.

TABLE I

COMPARISON OF ACID NUMBERS OBTAINED FOR DARK, OXIDIZED OILS BY POTENTIOMETRIC AND COLOR-INDICATOR METHODS

Test No.	Time of Oxidation, Hours	Saponification Number, Potentiometric Method, mg. KOH/g.	Acid Number, Potentiometric Method, mg. KOH/g.	Acid Number, Color-Indicator Method,* mg. KOH/g.
1	0	0.21	0.01	0.0
	8	9.4	1.91	1.2
	16	15.3	2.2	1.5
	24	17.5	3.6	2.1
	36	22.5	5.4	2.7
2	0	0.50	0.00	0.00
	8	24.1	5.9	4.5
	16	27.0	6.5	4.2
	24	28.0	6.8	4.2
	36	28.0	7.0	3.0
3	8	14.6	2.7	0.8
	16	27.4	4.5	1.6
	24	27.4	4.9	1.5
	36	30.1	5.5	1.5
4	8	9.4	1.1	0.5
	16	13.4	3.4	1.2
	24	11.2	2.0	1.1
	36	17.3	4.0	1.6
5	8	3.5	0.6	0.2
	16	6.6	1.4	0.4
	24	8.0	1.8	0.6
	36	10.8	2.2	0.9
6	8	10.5	1.9	0.8
	16	11.1	1.6	1.2
	24	14.7	2.2	1.3
	36	22.5	5.1	1.9
7	8	20.9	4.2	1.8
	16	43.4	7.9	6.0
	24	51.0	10.0	8.2
	36	56.0	12.9	8.7
8	8	25.0	5.9	4.6
	16	27.2	6.5	4.3
	24	28.4	6.7	4.3
	36	22.2	3.6	3.1
9	8	7.0	0.9	0.6
	16	8.3	1.2	0.5
	24	8.6	2.4	0.5
	36	11.9	2.8	0.5

* ASTM D663.

TABLE II

COMPARISON OF COMBINED ACID (SAPONIFICATION) NUMBERS OBTAINED FOR DARK OILS BY COLORIMETRIC AND POTENTIOMETRIC METHODS

Sample*	Saponification Number or Combined Acidity			
	ASTM D94-39T, Color-Indicator	ASTM D94-41T, Color-Indicator	Total Combined Acidity, Potentiometric	Strong Combined Acidity, Potentiometric
	Mg. of KOH per gram			
1	3.5	4.5	3.4	0.2
2	30.6	30.7	30.9	0.7
3	1.2	1.7	1.6	0.6
4	3.6	4.6	4.5	0.3
5	40.2	30.7	28.5	0.5
6	1.0	1.6	0.9	0.3
7	3.4	4.2	4.2	0.2
8	28.8	30.1	28.5	0.3
9	2.5	4.8	3.6	0.5
10	4.9	7.8	7.8	0.6
11	25.2	27.1	27.6	21.3
12	31.4	33.1	35.2	24.7
Degras oil	117.3	121.8	132.0	10.1
Sperm oil	135.6	138.6	139.5	0.6
Sulfurized	167.7	161.6	163.4	26.4

* Samples 1 to 12 are oxidized oil samples.

is indicated during the titration of a sample whenever the initial increments of base cause of the cG potentials to decrease instead of increase. Although the glass electrode may be partially at fault, this improper performance is usually caused by the condition of the interface between the salt solution in the calomel electrode and the titration solvent. The calomel reference electrode is rarely defective when new; it is more likely that it is apparently defective because of improper preparation for use or an unsuccessful attempt to repair or replace a broken part, such as a sleeve.

A defective or faulty glass electrode is indicated when the electrode system gives lower than normal potentials in aqueous solutions at pH 11 to 12 and when the replacement of the glass electrode with a new one increases the maximum cG potential attainable in the blank and/or increases the rate of equilibration between increments of base. Such a defective condition is not generally detectable by visual examination.

The following preparatory steps *must* be taken prior

to each titration to secure proper performance in nonaqueous titration:

1. After each titration, rinse the electrodes with benzene-isopropyl alcohol titration solvent, then with water and wipe thoroughly with a clean cloth. Rinse and replace the ground-glass sleeve and allow potassium chloride electrolyte to fill the ground area.

If this treatment does not leave the electrodes thoroughly clean, immerse them in chromic acid cleaning solution for several minutes, rinse them thoroughly with distilled water and allow them to stand in distilled water for several hours. If necessary, use cleaning solution to clean the ground surfaces of the calomel electrode. Whenever cleaning solution is used to clean the calomel electrode, drain the remaining electrolyte from the electrode and replace with fresh electrolyte solution. Immerse the electrodes in distilled water between titrations.

2. Immediately before each titration immerse both (clean) electrodes in distilled water for at least 2 minutes, remove from the water, and wipe with a clean cloth as before. Again remove the sleeve from the calomel electrode, dry each ground surface with a clean cloth, and replace the sleeve in such a manner that the ground surfaces are completely and copiously wetted with electrolyte solution. Be certain to leave a ring of electrolyte solution in the capillary space above and below the sleeve, so that good electrical contact is established at the electrolyte-solvent interface.

3. At all times, maintain the level of the electrolyte solution in the calomel electrode above the point to which the electrode is immersed in the titration or other medium.

4. Immerse the electrodes in the solution to be titrated and proceed with the titration.

To test a new set of electrodes, or an old set suspected of deterioration, a blank titration should be made in the benzene-isopropyl alcohol titration solvent as directed in the procedure for free acid; a record should be kept of the time required for equilibration after each increment as well as the final potential produced, and the titration of the blank, using 0.05-ml. increments, should be continued until the potential reaches its maximum value. When the electrode system is in good order and properly prepared, this test will yield a maximum potential on the blank titration curve of cG=0.7 to 0.8 volt and the average equilibration time will be less than 5 minutes per 0.05-ml. increment of base added

Actual tests have shown that failure to remove, clean, and replace the sleeve of the calomel electrode and to immerse both electrodes in water prior to every titration in benzene-isopropyl alcohol solvent causes serious distortion of the titration curve. Apparently a water film adheres to the surface of the glass electrode for the duration of the titration and, as long as this film remains unbroken, it provides the necessary conditions for equilibrium. Prolonged contact with the nonaqueous solvent (more than 90 minutes) tends to inactivate the electrode system, possibly by removing the water at points of contact. However, this does no permanent harm because contact with water during the preparation for the next titration restores the activity. The contact with water also removes any caustic film remaining on the electrodes from a previous determination.

With continued use in nonaqueous solutions, the characteristics of the glass electrodes change in such a manner that the maximum potential which can be obtained in the presence of excess base steadily drops. Thus, after six months continued use, the maximum potential obtainable may be only equivalent to a calculated cG value of 0.600 volt. The continued use of glass electrodes in a nonaqueous titration solvent alters their characteristics in two ways: (1) they tend to exhibit a gradually increasing reluctance to follow changes in hydrogen-ion activity in a normal way and (2) they become less and less accurate in measuring the hydrogen-ion activity.

The second and concluding part of this paper will appear in the June issue of LUBRICATION ENGINEERING. *It will cover the errors to be expected in the continued use of glass electrodes and methods of compensating for them, the titration meter and reflux apparatus, titration solvent, methods for free and combined acid and base numbers and further comments on accuracy and precision.*

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A more detailed, general discussion has been given previously in the paper "Potentiometric Determination of Acidity in Highly Colored Materials," by Messrs. Lykken, Porter, Ruliffson, and Tuemmler, *Ind. Eng. Chem., Anal. Ed., 16,* 219-34 (1944).

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Acknowledgment

The author gratefully acknowledges the contribution of Mrs. Jean R. Hoff and Mr. Paul E. Porter who aided in the preparation of the manuscript of this paper.

A. S. L. E.
SPRING MEETING
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STEVENS HOTEL
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April 5 & 6, 1946

Alemite Announces New Oil

Alemite Pennsylvania Motor Oil, heretofore marketed only as a straight run mineral oil, will hereafter be prepared with anti-oxidation and anti-corrosive additives to conform to the new American Petroleum Institute and Society of Automotive Engineers definitions of crankcase oils as a "premium motor oil," the Alemite division of Stewart-Warner Corporation announced recently. The new oil, to be known as "Alemite Pennsylvania Motor Oil with P. A." will be marketed at no advance in price over the former oil.

Alemite's new premium oil does not contain a detergent or dispersant agent. It contains only anti-oxidant and anti-corrosive compound, or inhibitors. The former is used to produce less oxidation products, such as sludge, varnish and oil thickening. Reduction of these undesirable oxidation products results in less sticking of piston rings and sticky pistons. Consequently, improved power, lowered gas consumption and longer life for the oil results.

"Corrosion inhibitors," as the term implies, prevent bearing corrosion, resulting in longer bearing life. Pitting of bearing surfaces by highly leaded gasolines is inhibited, or prevented, by such inhibitors.

Detergent or dispersant compounds are not added to the new Alemite Premium Oil because the oil is not designed to serve as an engine purge or cleaner, Alemite officials said. The new oil is designed to "keep a clean engine clean" while providing proper lubrication by anti-oxidant and anti-corrosion action only.

Other motor oils in the Alemite line, remaining unchanged, are Alemite Triple Safe Motor Oil and Alemite Triple Safe Heavy Duty and Diesel Motor Oil.

Lubricators For Industrial Bearings

Manufacturing rights on *Gun-Fil* lubricators have been acquired by the Gray Company, Inc., Minneapolis, Minnesota, manufacturers of lubricating equipment, it is announced by Mr. L. L. Gray, president. *Gun-Fil* lubricators are now in production as part of the Gray Company's industrial line of lubricating and maintenance equipment.

Designed in four sizes, with lubricant capacities ranging from ½ ounce to 8 ounces, pressure filled *Gun-Fil* lubricators automatically dispense oil or grease in a measured, uniform flow to a moving bearing, and stop feeding lubricant when a bearing becomes motionless, according to the manufacturer.

These highly efficient lubricators are said to assure controlled lubrication over a long period of time. Substantial labor savings may be effected, since the time between refilling is extended considerably over the periods required by conventional pressure fitting or grease cup methods.

Six interchangeable valves are available with distinctive colored caps for identification. The valves with colored caps exert varying degrees of control of feed on greases of different densities.

By feeding the precise amount of lubricant to each individual bearing, according to its needs, *Graco Gun-Fil* lubricators are said to offer modern dependable bearing lubrication.

For further information about *Gun Fil* lubricators, write the Gray Company, Inc., 60 11th Ave. N.E., Minneapolis 13, Minnesota.

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OILS AND LUBRICANTS PATENT ABSTRACTS

Vanadium Salts of Acid Esters as Inhibitors in Lubricating Oils—Patent #2,388,400—Frederick C. Frank, Darwin E. Badertscher, Henry G. Berger, assignors to Socony-Vacuum Oil Company. A mineral oil composition comprising a viscous mineral oil fraction and in admixture therewith a minor proportion, sufficient to inhibit oxidation, of vanadyl oleyl phthalate, said phthalate having the property of inhibiting ring-sticking of pistons even after it is removed and the pistons are contacted with a compounded or non-compounded mineral oil.

Fractionation of Tall Oil—Patent #2,388,412—Arthur W. Hixson, Ralph Miller, assignors to The Chemical Foundation, Inc. The process of extracting fatty acids from tall oil by contacting same with a liquefied, normally gaseous, hydrocarbon at elevated temperatures at which the rosin is insoluble in the liquefied hydrocarbons in a continuous counter-current system, continuously withdrawing from said system one liquid phase consisting essentially of fatty acids dissolved in the liquefied hydrocarbon and a second phase consisting essentially of liquid rosin containing some dissolved hydrocarbon.

Cutting Oil—Patent #2,388,439—Leslie R. Raymond, assignor to A. S. Cowie and Co. A cutting oil consisting principally of mineral lubricating oil and naphthenic acid in proportions between 5% and 75% naphthenic acid to between 95% and 25% mineral lubricating oil, by volume, and also containing from ½% to about 5% by weight of metallic naphthenate.

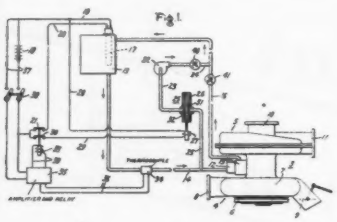
Fig. 1.

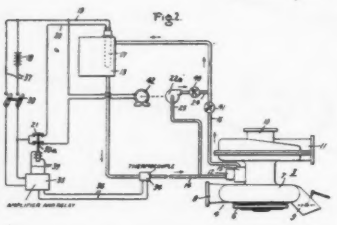
Fig. 2.

Lubricant Heating System for Turbosuperchargers and the Like—Patent #2,388,523—Joseph C. Buescher, assignor to General Electric Co. In combination, a turbosupercharger, a lubricant tank, pump means connected with said tank for conveying lubricant from the tank to turbosupercharger parts requiring lubrication and thence back to the tank, a second pump means in shunt to said first-named pump means for effecting circulation from and back to the tank, a heating element in the tank, and means responsive to the temperature of the lubricant for controlling said heating element and the circulation of lubricant by said second pump means.

Rubber Lubricating and Plasticizing Composition—Patent #2,388,618—Morris Omansky, assignor, by mesne assignments, to Victor Chemical Works. A rubber composition of matter comprising a rubber and a plasticizing proportion of a neutralized phosphated castor oil.

Lubricant Conditioner—Patent #2,388,636—Frank B. Harvuot, assignor to S. F. Bowser and Company, Inc. In a lubricant conditioner, the combination of a flow line for said lubricant, a compartment containing wash fluid of higher specific gravity than said lubricant, an oil separating device comprising an inverted container having a flat top wall and a downturned rim, a plurality of small, diffusion orifices in said top wall for forming droplets of lubricant, submerged in said wash fluid, said flow line being disposed to open into said container from below so that a body of lubricant will collect in said container adjacent said orifices, means for limiting the rate of flow of lubricant to the container to at least the rate of flow of lubricant from said container, and means for leveling said container.

The abstracts in this issue are from the Official Gazette — Vol. 580, Nos. 1, 2, 3, 4; Vol. 581, Nos. 1, 2, 3, 4; Vol. 582, Nos. 1, 2, 3, 4, 5. They cover the period from Nov. 6, 1945, through Jan. 29, 1946, inclusive.

Printed copies of patents are available from the Patent Office at 10c each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

Soluble Oil and Process for Producing Same—Patent #2,388,677—Charles A. Cohen, assignor to Standard Oil Development Co. A method for producing a soluble oil which comprises contacting a sulfuric acid-treated oil while in an acid condition with a finely divided substance selected from the group consisting of diatomaceous filter aids, tripoli, and activated carbon to form a finely divided substance-pepper sludge complex, removing the finely divided substance-pepper sludge complex and sulfur dioxide and neutralizing.

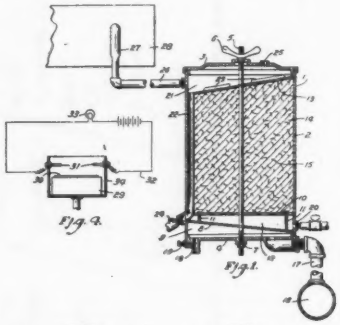
Fig. 4.

Fig. 1.

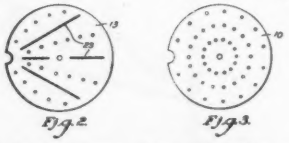
Fig. 2.

Fig. 3.

Oil Refining Means — Patent #2,388,821 — Anita Margot Braun. An oil refining device for use in association with an internal combustion engine comprising a cylindrical container having substantially horizontally disposed top and bottom closure members, a partition member in the container spaced a short distance from the bottom member and being slightly inclined with respect thereto, said partition member forming a heating chamber in the bottom portion of the container having a restricted portion and an enlarged portion, an inlet in the restricted portion of the heating chamber for a heating fluid, a substantially horizontally disposed perforated circular plate in the container spaced slightly above said partition member and forming between said plate and partition member an oil preheating chamber having a restricted portion and an enlarged portion, a slightly inclined and substantially circular perforated plate in the container spaced slightly below the top member and forming between said plates a filter chamber occupying the major portion of the container, a body of filtering material in said filter chamber, means for circulating the oil supply of said engine successively through the oil preheating chamber and the filter chamber, said oil preheating chamber having an inlet for said oil supply in the enlarged portion thereof, and an outlet for treated oil communicating with the space between the second perforated plate and the top of the container.

Treatment of Hydrocarbon Oils—Patent #2,388,937—Louis Schmerling and Vladimir N. Ipatieff, assignors to Universal Oil Products Company. A process for the destructive hydrogenation of hydrocarbonaceous material which comprises reacting said material mixed with hydrogen in the presence of a zinc chloride and aluminum oxide.

Lubricating and Corrosion-Preventing Composition—Patent #2,389,090—James E. Shields and Ulric B. Bray, assignors to Alox Corp. A preservative lubricant composition substantially consisting of a highly refined hydrocarbon oil derived from Venezuelan or Pennsylvanian crude oil and having a pour point at least as low as —40F containing dissolved therein from about 3.0% to about 4.5% by weight of calcium soaps of acids derived from the oxidation of a petroleum lubricating oil substantially free from crystalline bodies, asphalts and unsaturated hydrocarbons, and from about 0.5% to about 1.0% by weight of lower alkyl esters of said acids, the resulting solution also containing a small amount of an oxidation-depressing thio-ether of an alcohol, said preservative lubricant composition having a pour point at least 20F below that of the hydrocarbon oil component of the composition.

Hydrocarbon Oil Composition—Patent #2,389,110—Elmer W. Cook and William D. Thomas, Jr., assignors to American Cyanamid Company. A lubricating oil composition for the lubrication of steam turbines comprising a major proportion of a hydrocarbon lubricating oil and from 0.02 to 5.0% of a water-insoluble mixture of approximately equal parts by weight of a primary alkyl amine having from 16 to 18 carbon atoms and an oil-soluble alkyl phenol.

Refining of Coke-Oven Light Oil—Patent #2,389,172—Bernard J. C. van der Hoeven and John Walker Unroe, assignors, by mesne assignments, to Koppers Company, Inc. In a process for the refining of crude light oil that is obtained from coke-oven gas, the steps of: continuously flowing non-acid washed crude light oil aforesaid into a fractionating column; boiling said light oil therein and simultaneously treating evolved vapors with a reflux of forerunnings' constituents of said light oil having a boiling point lower than benzene at a rate, by volume, at least about one and one-half times the rate, by volume, at which said crude light oil is flowed into said fractionating column and thereby separating said crude light oil into a plurality of fractions comprising a low-boiling forerunnings fraction that is substantially free of benzene, another fraction containing some benzene and a relatively high concentration of non-aromatic light-oil constituents having boiling points lower than but more closely adjacent the boiling point of benzene than the constituents of the first said fraction, said other fraction having a specific gravity of from 0.79 to 0.83, and a distillation residuum containing at least substantially ninety-five per cent of the benzene originally present in the light oil, said residuum being free of fore-runnings and non-aromatic hydrocarbon constituents of light oil having boiling points less than benzene; recovering the plurality of said fractions; and acid-washing said residuum and fractionally distilling therefrom without substantial production of lower boiling intermediates, about ninety per cent of the total originally contained benzene of said light oil as a product having a solidifying point of at least 4.85C.

Condensed Halogenated Tall Oil Products and Method for Making the Same—Patent #2,389,203—Eugene Lieber, assignor to Standard Oil Development Company. An improved wax modifier comprising a Friedel-Crafts condensation product of about one part by weight of halogenated "tall oil" and about 3 to 4 parts by weight of an aromatic organic compound.

Pneumatic Tool Lubricant—Patent #2,389,227—Donald L. Wright, assignor to Standard Oil Development Co. A lubricant having a viscosity in the range of about 150 to 1000 seconds Saybolt at 100F adapted for use in compressed air and steam motivated machines having high speed reciprocating pistons, which comprises a major proportion of a hydrocarbon lubricating oil and about 1 to 15% of a non-drying thickened fatty oil and about 0.1 to 1.0% of a linear oxygen-containing polymer which normally is plastic to solid, has an iodine number below 20 and a molecular weight of at least 1000, said polymer being a polymer of an oxygen-containing organic compound.

Selectively Hydrogenated Tall Oil and Method of Making Same—Patent #2,389,284—Joseph Abrahm Valentine Turck, Jr. and John Ross, assignors to Colgate-Palmolive-Peet Co. The process of saturating olefinic bonds of unsaturated fatty acids in tall oil which comprises treating tall oil with hydrogen at a pressure of at least 50 pounds per square inch in the presence of a nickel catalyst and at a temperature above 50C but below 135C.

Lubricating Composition—Patent #2,389,513—Lebbeus C. Kemp, Jr., assignor to The Texas Co. A lubricant comprising a hydrocarbon oil containing 0.1—10.0% by weight, based on the finished lubricant, of an organic ester of phosphoric acid, said organic ester being derived from a long chain unsaturated alkyl phenol present in or derived from oils extracted from the Anacardium genus of the Anacardiaceae family.

Barium Calcium Magnesium Stearate Grease—Patent #2,389,523—Frank A. Leyda, assignor, by mesne assignments, to California Research Corp. A mixed base, anhydrous grease consisting of mineral oil and soaps of barium, magnesium and at least one metal of the group consisting of calcium and strontium, said magnesium soap being present in proportions ranging from 10 to 20% of the soaps present so as to produce a thermally reversible grease.

Lubricants—Patent #2,389,527—Rush F. McCleary, assignor to The Texas Co. A lubricant comprising a hydrocarbon lubricating oil having incorporated therein 0.01—5.0% by weight of an oil-miscible metal salt of a sulfur-containing substituted acid of phosphorus possessing at least one ester radical derived from a sulfurized unsaturated alkyl phenol containing at least five carbon atoms in the unsaturated alkyl radical thereof.

Temperature Control for Hydrocarbon Oil Processing—Patent #2,389,604—Leonard F. Dowding, assignor to The Texas Company. The cyclic method of controlling the temperature in a refinery hydrocarbon oil processing step, which comprises stabilizing and fractionating a hydrocarbon fraction to separate a normally gaseous hydrocarbon from heavier hydrocarbons, passing said normally gaseous hydrocarbon in liquefied form through a chilling zone in indirect heat exchange with the hydrocarbon oil being processed, whereby a portion of the liquefied normally gaseous hydrocarbon is vaporized, removing the vapors to a zone of compression and cooling for liquefaction and returning the liquefied refrigerant to the chilling zone, recirculating the refrigerant through repeated stages of said compression and cooling for liquefaction and indirect heat exchange for evaporation, whereby the refrigerant tends to become contaminated with heavier liquid impurities which accumulate in the chilling zone, withdrawing a minor portion of the contaminated liquefied refrigerant from the chilling zone, mixing the same with the said hydrocarbon fraction and then subjecting the resulting mixture to the stabilizing and fractionating operation, whereby the hydrocarbon refrigerant is separated from the heavier liquid impurities, and returning the separated purified hydrocarbon refrigerant together with any additional make-up normally gaseous hydrocarbon from said stabilizing and fractionating operation to the chilling zone.

Lubricating and Penetrating Oil—Patent #2,389,608—Jose B. Calva. A lubricating substance containing in its composition up to 25% cyclohexanone but in sufficient quantity to reduce the coefficient of friction.

Aqueous Polyisobutylene Emulsions—Patent #2,389,796—Gerry P. Mack, assignor to Advance Solvents and Chemical Corp. A process for making purely aqueous emulsions of polyisobutylene having an average molecular weight above 27,000 which process comprises the steps of kneading the polyisobutylene with an aqueous liquid and an emulsifying agent selected from the group consisting of the water soluble alkali metal and ammonium soaps of the fatty acids having more than 10 carbon atoms in the molecule and the mixtures of such soaps with the corresponding unreacted fatty acids until a thorough dispersion of the emulsifying agent and liquid in the polyisobutylene mass has been obtained and the mixture has become plastic, then causing an instantaneous inversion of the dispersion by adding thereto a peptizing agent selected from the group consisting of the mineral oil sulfonates and the alkali metal sulfonates of the alkyl-aryl compounds containing at least 12 carbon atoms in the molecule, at least three of said carbon atoms being disposed in one aliphatic chain, and diluting the resulting paste with an aqueous liquid.

Low Temperature Lubricants—Patent #2,389,924—John D. Morgan, assignor to Cities Service Oil Co. A lubricant for metallic bearing surface having viscosity characteristics adapted to provide effective lubrication at extremely low temperatures as well as at temperatures above normal atmospheric temperature, consisting essentially of a picoline having dissolved therein a small proportion of an extreme pressure agent sufficient to impart extreme pressure properties to the lubricant.

Process for Breaking Petroleum Emulsions—Patent #2,390,078—Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp., Ltd. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a basic esterified aminoalcohol of the formula:

$$\begin{matrix} R \\ R_1 \end{matrix} > N.R_2OOCR_3$$

in which R is a monovalent radical free from ether linkages and having at least 8 carbon atoms and not more than 32 carbon atoms and a member of the class consisting of aliphatic hydrocarbon radicals, alicyclic hydrocarbon radicals and aralkyl hydrocarbon radicals; R_2 is a divalent radical having less than 16 carbon atoms and not more than 3 ether linkages and a member of the class consisting of alkylene radicals, hydroxy-alkylene radicals, alkyleneoxy radicals, hydroxy-alkyleneoxy radicals, polyglycol and hydroxy polyglycol radicals in which any alkylene radicals present are selected from the group consisting of ethylene, propylene, butylene and methyl-propylene; and R_1 is a monovalent radical and a member of the class consisting of aliphatic hydrocarbon radicals, alicyclic hydrocarbon radicals, aralkyl hydrocarbon radicals having not more than 32 carbon atoms and the monovalent radical HOR_2, wherein R_2 has its prior significance; R_3CO is an acyl radical of a low molal mono-carboxy acid having less than 8 carbon atoms.

Process for Breaking Petroleum Emulsions—Patent #2,390,079—Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp., Ltd. A process for resolving petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifier, comprising a sub-resinous esterification product of the formula:

$$(OH)n(Yy'Xx')q \diagup \begin{matrix} (COOH)m \\ (COOZ)m' \end{matrix}$$

in which X is a polycarboxy acid radical selected from the class consisting of polycarboxy acids, anhydrides, monohydric alcohol esters and polyhydric alcohol esters, with the proviso that the alcohol radical of said esters be free from detergent-forming monocarboxy acid radicals, and y' represents a whole number not greater than 3, and x' represents a whole number not greater than 5, and n, m and m' indicate whole numbers from 0 to 40; q indicates a whole number from 1 to 20; Z is a hydrogen ion equivalent; Y is the radical of a basic esterfied amono-alcohol.

Process for Breaking Petroleum Emulsions—Patent #2,390,080—Melvin De Groote and Bernhard Keiser, assignors to Petrolite Corp., Ltd. A process for resolving petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifier, comprising a sub-resinous esterification product.

Process for Breaking Petroleum Emulsions—Patent #2,390,081—Melvin De Groote, assignor to Petrolite Corp., Ltd. A process for breaking petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifying agent comprising a basic esterified ether-aminoalcohol.

Process for Breaking Petroleum Emulsions—Patent #2,390,082—Melvin De Groote, assignor to Petrolite Corp., Ltd. A process for resolving petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifier, comprising a sub-resinous esterification product.

Process for Breaking Petroleum Emulsions—Patent #2,390,083—Melvin De Groote, assignor to Petrolite Corp., Ltd. A process for resolving petroleum emulsions of the water-in-oil type, characterized by subjecting the emulsion to the action of a demulsifier, comprising a sub-resinous esterification product.

Method of Increasing Cetane Number of Fuel Oil—Patent #2,390,296—George R. Gilbert, assignor to Standard Oil Development Co. A method of treating sour fuel oil to increase the cetane number thereof comprising the steps of agitating a first batch of sour oil with approximately 50° Baumé caustic solution and in the ratio of approximately 15 parts of oil to 1 part of caustic in the presence of oxygen at a temperature of approximately 190F until the batch is sweet, separating under the influence of gravity the oil from the caustic, admixing another batch of sour fuel oil with caustic, removed from said first batch, agitating it in the presence of oxygen at a temperature of approximately 190F until the oil is sweet and separating under the influence of gravity the oil from the caustic.

Compounded Hydrocarbon Products—Patent #2,390,342—David W. Young, assignor to Standard Oil Development Co. A lubricant comprising a major proportion of a mineral oil of the lubricating oil range and about 0.02% to about 5% of a compound of the formula

where R is an aliphatic radical and T is a salt forming entity selected from the group consisting of hydrogen, a metal valence equivalent of hydrogen, the metal being selected from groups I, II, III, IV and VIII of the periodic table and a non-metallic basic group.

Processes of Extracting Constituents of Mineral Oils—Patent #2,390,429—Eddie M. Dons and Oswald G. Mauro, assignors to Mid-Continent Petroleum Corp. In the art of using selective solvents to extract naphthenic constituents of waxy mineral oils, the process of recovering selected paraffinic components from the extract solution which comprises continually transmitting an extract solution from an extractor to a cooled settling chamber, discharging relatively heavy extract solution from the lower portion of said cooled settling chamber, discharging a rising mass of waxy paraffinic raffinate solution from the upper portion of said cooled settling chamber to a much smaller cleansing zone immediately above and in free communication with said settling chamber, heating said rising mass of waxy paraffinic raffinate solution at the upper portion of said settling chamber to provide a relatively high temperature in said smaller cleansing zone, and introducing a stream of relatively heavy selective solvent into said rising mass of heated paraffinic raffinate in the cleansing zone, so as to selectively dissolve and return selected constituents of the outgoing paraffinic raffinate to said settling chamber.

Apparatus for Extracting Constituents of Mineral Oils—Patent #2,390,430—Eddie M. Dons and Oswald C. Mauro, assignors to Mid-Continent Petroleum Corp. In an apparatus for extracting constituents of waxy lubricating oils, including a counterflow extractor wherein a selective solvent is employed to separate a relatively heavy naphthenic extract solution from a lighter waxy, paraffinic raffinate solution, said extractor having an outlet for the separated extract solution, the means for recovering a second waxy paraffinic raffinate from said extract solution which comprises a large settling chamber wherein all the waxy paraffinic components of the second raffinate are selectively separated from the extract solution, means for cooling said extract solution to produce a relatively low temperature condition in the settling chamber, said settling chamber having an inlet communicating with said outlet for the separated extract solution, the lower portion of said settling chamber having an outlet for relatively heavy extract solution, the upper portion of said settling chamber being provided with an outlet for a rising stream of outgoing waxy paraffinic raffinate solution from the settling operation, a heater located near the top of said settling chamber to heat the outgoing waxy stream, said settling chamber being large enough to maintain a large body of the extract solution in a quiescent condition for a period sufficient to selectively separate all of the paraffinic components of said second waxy raffinate from the relatively heavy extract solution in said settling chamber, and means for dissolving and returning degrading components of said outgoing raffinate solution to said large settling chamber, said means including a much smaller counterflow cleansing compartment extending upwardly from the outlet at the upper portion of said settling chamber to receive the rising paraffinic raffinate solution and a descending stream of cleansing solvent, said extended compartment having an inlet for the cleansing solvent and an outlet for the second raffinate solution, and the outlet at the upper portion of said settling chamber being in direct communication with the bottom of said upwardly extended cleansing compartment to provide for upward discharge of the second paraffinic raffinate solution and downward return of said degrading components.

Lithium Base Greases—Patent #2,390,450—John D. Morgan, assignor to Cities Service Oil Co. A lubricating composition comprised principally of a lubricant oil, from about 4% to about 12% by weight of a lithium soap, from about 0.5 to 3% by weight of an aluminum soap, and from about 0.5 to 2.5% by weight of a rubber as an agent for preventing the bleeding of the grease composition.

A lubricant comprised principally of a lubricating oil and containing from about 4% to about 12% by weight of a lithium soap of castor oil and a relatively small but sufficient proportion of lithium naphthenate as a stabilizer for the oil and soap.

Lubricant—Patent #2,390,491 — Harry T. Bennett and Jerry R. Marshall, assignors to Mid-Continent Petroleum Corporation. A lubricant comprising a petroleum lubricating oil wherein foaming is inhibited by an acetyl ester of a sulfonated ricinoleic acid dissolved in said oil, the quantity of said ester being about 0.05% of the lubricant.

Lubricant—Patent #2,390,492—Harry T. Bennett and Jerry R. Marshall, assignors to Mid-Continent Petroleum Corporation. A lubricant comprising a petroleum lubricating oil wherein foaming is inhibited by an alkyl ester of a sulfonated ricinoleic acid dissolved in said oil, the quantity of said ester being about 0.05% of the lubricant.

Oil Filter—Patent #2,390,539—Morris Katcher. An oil filtering device comprising a housing enclosing a chamber, means in the chamber for filtering the oil on its way through, said chamber having an inlet for receiving the oil on one side of the filtering means from the pressure side of a lubricating system, an outlet from the chamber to the lubricating system on the opposite side of the filtering means for the discharge of the oil after having passed through the filtering means, a duct connecting the outlet and inlet for bypassing the oil from the pressure side of the lubricating system to the outlet before passing to said opposite side of filtering means, a valve for the duct having a movable part and a spring, said spring normally causing the movable part to set in position to prevent bypassing of oil through the duct during the filtering of the oil, said part moving against the pressure of the spring to set in position to open up the duct for the flow of oil through it to the outlet when the pressure in the chamber exceeds a predetermined amount due to the clogging of the filtering means, and detent mechanism releasably holding the movable part in fixed open position regardless of further fluctuations of pressure in the chamber, once said part has been actuated to set in open position.

Lubricant Compressor—Patent #2,390,781 — Ernest W. Davis, assignor to Stewart-Warner Corporation. In a lubricant compressor having a lubricant reservoir, the combination of a cylinder receiving lubricant from the reservoir, a piston longitudinally movable within said cylinder, a piston rod for said piston, a single manually operable means for imparting longitudinal reciprocatory movement to said piston rod and said piston thereby to apply pressure to the lubricant in said cylinder, a lubricant discharge conduit surrounding said piston rod and receiving lubricant from said cylinder, said conduit having a pressure release opening therein, means including a portion of said piston rod covering said pressure release opening throughout said pumping movement and uncovering said pressure release opening upon abnormal additional longitudinal movement of said piston rod, said manually operable means being selectively operable to impart either said pumping movement or said abnormal movement to said piston rod, and means for applying a substantial resistive force opposing abnormal movement of said piston rod.

Oil Burning System—Patent #2,390,806—Theodore Nagel. An oil burning system comprising a plurality or nest of oil burner nozzles at a firing opening of a furnace, an electrically operated oil valve for each of said nozzles, with one exception, oil pressure operated switch mechanism for controlling said valves, and an oil pressure valve controlled by the steam pressure generated by the furnace for controlling said switch mechanism.

Process for Removing Copper Compounds From Copper-Sweetened Hydrocarbon Oil — Patent #2,390,868 — Kenneth M. Brown, assignor to Universal Oil Products Co. A process for removing copper compounds from copper-sweetened hydrocarbon oil which comprises treating said oil with basic magnesium carbonate in solid form.

Process for Refining Petroleum Oils—Patent #2,390,-917—Ferdinand W. Breth and Anthony Kinsel, assignors to L. Sonneborn Sons, Inc. The process of refining petroleum hydrocarbons, which comprises bringing said hydrocarbons into intimate contact with thermally activated bauxite predominating in particles of a particle size within the range of 20 to 80 mesh, which have been contacted at a temperature of from 1000F to 1200F with a current of preheated air having a velocity of from 4 to 6 feet per second to substantially free said particles of adherent relatively finer particles inseparable therefrom by screening, said air being at a temperature of from 120F to 220F at the point of first contact with said bauxite and at a temperature of from 200F to 250F at the point of last contact with said bauxite.

Compounded Hydrocarbon Oil—Patent #2,390,943—Frank W. Kavanagh, Bruce B. Farrington, and James O. Clayton, assignors, by mesne assignments, to California Research Corp. A lubricant comprising a major proportion of a hydrocarbon lubricating oil and a small amount each, sufficient to stabilize the oil against heat and oxidation, of a metal salt of a phenol and an oxidation inhibitor containing a benzene nucleus to which are directly attached at least two substituents selected from the group consisting of amino radicals and oxy radicals.

Process for Refining Oil and for Producing Soap—Patent #2,390,990—Benjamin Clayton, assignor, by mesne assignments, to Refining, Unincorp. The process of refining animal and vegetable oils, which comprises, subjecting a relatively dry mixture containing neutralized oil and soap stock to centrifugal separation in the presence of a hydrating agent containing a soap selected from the group consisting of rosin and naphthenic acid soaps.

Lubricating System for Aircraft Superchargers—Patent #2,391,000—Wayne H. Allen, assignor to General Electric Co. The combination with a supercharger system for an aircraft including an air cooler on the discharge side of the supercharger, of a lubricant tank, and conduit means connecting the tank above the lubricant therein to opposite sides of said air cooler to bypass compressed heated air with regard to the cooler in order to heat lubricant in the tank.

Oil Solubilizing Compositions—Patent #2,391,087—Theodore R. Donlan and Albert Gathman, assignors to Standard Oil Development Company. An oil solubilizing composition, comprising a mineral oil soluble sulfonate extracted from a petroleum oil in an amount between 50 and 80 per cent by weight, a mono-unsaturated fatty acid containing about between 10 and 20 carbon atoms in the molecule, in an amount between about 2 and 5 percent by weight, a sodium-alkyl-naphthalene-sulfonate in an amount between about 1 and about 4 per cent by weight, and between 15 and 25 per cent by weight of a monohydric alcohol containing between 3 and 6 carbon atoms in the molecule.

Refining Petroleum Oils—Patent #2,391,091—Amiot P. Hewlett and Gerald E. Phillips, assignors to Standard Oil Development Company. Process for the treatment of prime cut petroleum oils comprising contacting said petroleum oils with a catalyst consisting of bauxite in the vapor phase at a temperature in the range from about 780F to 850F whereby substantially no cracking of the oil occurs and substantially no gas is formed.

Lubricating Oil Composition—Patent #2,391,099—John G. McNab and Carroll J. Wilson and Carl Winning, assignors to Standard Oil Development Company. A lubricant comprising a major proportion of a mineral oil base stock, about 0.02% to about 2.0% of a salt of a polybasic inorganic acid which contains at least one oil-solubilizing substituent organic group, said salt being a salt of a metal selected from groups I, II, III, IV, and VIII of the periodic table and having a tendency to cause corrosion of metal surfaces during use in said lubricant, and about 0.02% to about 2.0% of an alkylation product obtained by reacting p-cresol with isobutene in the presence of a catalytic amount of sulfuric acid said product having a molecular weight of about 220, a chemical composition corresponding to the empirical formula

$$C_{15}H_{24}O$$

and being, when purified, a white crystalline solid having a melting point of about 69.2 to about 69.4C.

Lubricating Composition—Patent #2,391,113—John C. Zimmer and Arnold J. Morway, assignors to Standard Oil Development Company. A water-resistant, high temperature, extreme pressure lubricant of the grease type, consisting of about 78.71% asphaltic base lubricating oil having a viscosity of 72 SSU at 210F, 9.29% lithium soap of hydrogenated fish oil acids, 9% lead oleate, 0.5% zinc naphthenate, 0.5% aluminum stearate and 2% chlorinated wax.

Compounded Hydrocarbon Oil—Patent #2,391,184—Joseph F. Nelson and Louis A. Mikeska, assignors to Standard Oil Development Company. An improved lubricant which comprises an oil base and a small quantity, sufficient to substantially inhibit deterioration of the oil during use, of a compound of the formula

$$[(RX)a(HY)bPZc]dM$$

in which R is an organic group, X, Y, and Z are elements of the group consisting of oxygen, sulfur, selenium, and tellurium, at least one atom being a member of the class consisting of sulfur, selenium and tellurium, H is hydrogen, P is phosphorus, M is a polyvalent metal, a, c, and d are small whole numbers, b is zero or one, and a $+ b + c = 3$.

Lubricating Composition—Patent #2,391,311—William Helmore, assignor to C. C. Wakefield and Co., Ltd. A lubricating composition substantially non-corrosive to bearing materials of the composite metal type including cadmium-nickel bearing materials even at temperatures of the order of 170C and having high film-rupture strength at such temperatures, which composition comprises, a lubricating oil base having incorporated therein as addition materials, at least 0.1% tin oleate, at least 0.5% of phosphate selected from the group consisting of tricresyl phosphate, triphenyl phosphate and trinaphthyl phosphate and at least 0.1% of phosphite selected from the group consisting of tributyl phosphite and triamyl phosphite, all by weight based on the weight of the lubricating oil base, the total amount of said addition materials being not greater than 10%.

Compositions and Processes—Patent #2,391,631—Richard W. Kingerley, Jr., assignor to E. I. du Pont de Nemours and Co. A lubricant for use in the cold rolling of steel comprising a major amount of mineral oil, from about 0.2 to 0.5 per cent sulfonated castor oil, 0.5 to 2.0 per cent tricresyl phosphate, and from about 0.05 to 0.3 per cent of lorol phosphate.

Goldbeater Lubrication Material—Patent #2,391,653—Donald D. Swift, assignor to M. Swift and Sons, Inc. The method of preparing a lubricant for metal beating, comprising the steps of dissolving sodium palmitate in alcohol, mixing completely dehydrated calcium sulphate uniformly therein to obtain a suspension of the calcium sulphate in the solution of sodium palmitate, and evaporating the alcohol.

Goldbeater's Lubricant—Patent #2,391,654—Donald D. Swift, assignor to M. Swift and Sons, Inc. The method of preparing a lubricant for metal beating, comprising the steps of dissolving sodium stearate in alcohol, mixing completely dehydrated calcium sulphate uniformly therein to obtain a suspension of the calcium sulphate in the sodium stearate solution, and evaporating the alcohol.

Lubricating Arrangement for Power-Driven Saws—Patent #2,391,730—William T. Melvin and Rene Louis Rougemont, assignors to Reed-Prentice Corporation. A lubricating arrangement for chain saws comprising, in combination, a cutter bar, a chain saw driven thereon, a lubricant reservoir, offset from one end of said cutter bar, said reservoir providing spaced side walls, connections extending between said reservoir and one side of said cutter bar, means for maintaining lubricant within said reservoir under pressure, ports at opposite sides of said reservoir leading to said connections, a valve member extending entirely across and within said reservoir providing passages for conducting lubricant to the saw through one or the other of said ports and connections, in accordance with which port is below the level of lubricant within the reservoir, said valve member also extending through both side walls of said reservoir, and an operating member on each end of said valve member, outside the corresponding side wall, for turning said valve member into different positions.

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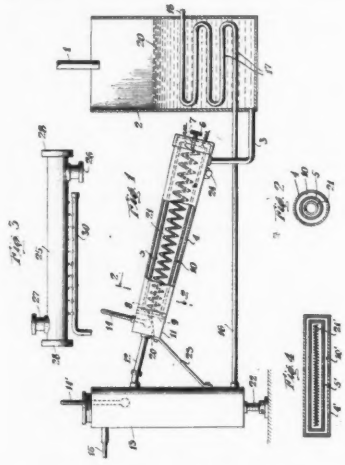
Lubricating Greases—Patent #2,391,842—John D. Morgan, assignor to Cities Service Oil Co. A lubricating composition having a grease structure made by heating a mixture comprised principally of a lubricating oil and from about 4% to about 20% by weight of a silver soap of a higher fatty acid to a temperature of approximately 400F, said composition having a stable plastic gel-like consistency.



Process for Dehydrating Oil—Patent #2,392,119—Ivor M. Colbeth, assignor to The Baker Castor Oil Co. The process of dehydroxylating glyceride oils, which comprises introducing the oil into the lower end of an inclined space of such shape that the oil is in a thin layer, and applying sufficient heat to the oil to vaporize it.

Lubricant—Patent #2,392,252—Robert L. May, assignor to Sinclair Refining Co. A lubricating oil composition comprising a petroleum lubricating oil and a proportion effective to retard oxidation of the composition of an inhibitor such as results from the reaction of a monohydroxy aliphatic alcohol with a condensation product of turpentine and phosphorus pentasulfide.

Lubricant—Patent #2,392,253—Robert L. May, assignor to Sinclair Refining Co. A lubricating oil composition comprising a petroleum lubricating oil and a proportion, effective to retard oxidation of the composition, of the reaction product of zinc oxide and an organic compound resulting from the reaction of a monohydroxy aliphatic alcohol, having not fewer than 5 carbon atoms per molecule, with a condensation product of turpentine and phosphorus pentasulfide.

Treatment of Vegetable Oils—Patent #2,392,390—Percy L. Julian and Herbert T. Iveson, assignors to The Glidden Co. The process of producing non-break vegetable oil which comprises first treating the oil with acid clay having a pH less than 5, removing the acid clay from the oil, then treating the oil under substantially anhydrous conditions with fuller's earth having a pH greater than 8, removing any phosphatides present in the original oil prior to the treatment with alkaline fuller's earth, and finally removing the alkaline fuller's earth from the oil.

Organic Phosphorus Lubricant Compositions — Patent #2,392,468 — Ernest F. Engelke, assignor to Cities Service Oil Company. An improved lubricating oil composition comprised mainly of a lubricating oil and from approximately 0.05 to approximately 1.5% of a compound having a general formula selected from the group consisting of

$(RO)_2PR'$, $(RO)PR'_2$, $(RO)_2PXR'$, & $(RO)PXR'_2$,

wherein R represents a radical selected from the group consisting of alkyl radicals containing from 4 to 7 carbon atoms and aryl radicals containing a single phenyl ring. R1 represents an abietate directly attached to phosphorus with a P-C linkage, and X represents an element selected from the group consisting of oxygen and sulfur, said compound having the property of greatly increasing the film strength of the lubricating oil.

Lubricating and Hydraulic Composition — Patent #2,392,530—William F. Hamilton, Melvin F. George, Jr., and Glenn B. Weible, assignors to Lockheed Aircraft Corporation. A liquid composition of matter consisting essentially of a major proportion of alkyl phosphate having from 1 to 5 carbon atoms inclusive in the alkyl radicals and a minor amount of a synthetic thermo-plastic resin of the group consisting of the class of thermo-plastic compounds having the general formula

$$R—(C_6H_{10}O_5)n$$

in which R is an alkyl, aryl or acid radical.

Method for Improving the Cetane Value of a Hydrocarbon Fuel Oil—Patent #2,392,570—Henry G. Berger and Darwin E. Badertscher, assignors to Socony-Vacuum Oil Company, Inc. The method for improving the cetane value of hydrocarbon fuel oil containing aromatic constituents and characterized by a relatively low cetane value, which comprises: treating said fuel oil with substantially only an aliphatic aldehyde and hydrofluoric acid, thereby converting said aromatic constituents to resinous materials; and separating said fuel oil substantially free from said aromatic constituents and characterized by a cetane value substantially greater than the cetane value of the untreated fuel oil, from said resinous materials.

Stable Sulphurized Oils and the Method of Preparing Same — Patent #2,392,891 — Joseph S. Wallace and Thomas E. Sharp, assignors to Standard Oil Co. A stable, non-emulsifiable sulphurized mineral oil comprising a sulphurized mineral oil prepared by reacting an oil with elemental sulphur at a temperature from about 300F to about 360F, and an oil soluble sulphonate selected from the class consisting of alkali metal sulphonates, alkaline earth sulphonates and amine sulphonates, said sulphonate being employed in a small but sufficient amount to inhibit the formation of sediment in said sulphurized oil.

Process of Refining Oil—Patent #2,392,973—Benjamin Clayton, assignor by mesne assignments, to Refining, Unincorp. In the process of recovering a neutral oil from crude fatty oils containing gums including phosphatidic material, which process includes mixing said oil with a non-saponifying neutralizing agent and separating the resulting soap stock from said oil in the presence of substantial amounts of water, the improvement which comprises, supplying sufficient heat to said oil, prior to separating said soap stock therefrom to set a substantial portion of said phosphatidic material therein but insufficient to cause gums to be rendered insoluble in dry oil, to thereby produce a substantially neutralized oil containing a substantial amount of said phosphatidic material after separation of said soap stock.

Blended Lubricating Oils—Patent #2,393,212—David W. Young and Theodore J. Peters, Jr., assignors to Standard Oil Development Company. The method of treating a liquid petroleum product containing small quantities of free or loosely combined sulfur to inhibit the tendency of such product to deposit a copper sulfide stain on the surfaces of copper and copper alloys with which such product comes into contact which comprises adding to said petroleum product in liquid phase a compound, substantially inert to said product, of the formula RCN where R is a member of the class consisting of aliphatic and aromatic radicals.

Reclaiming Used Lubricating Oils—Patent #2,393,335—John M. Musselman, assignor to The Standard Oil Company. A process of reclaiming mineral oils which have been used for the lubrication of an internal combustion engine and which contain degradation products, which process comprises heating said used oil with a phosphorous sulfide as a principle reactant with said used oil to a temperature to effect a reaction therebetween to improve the lubricating characteristics of the oil, and separating precipitated matter.

High-Temperature Greases — Patent #2,393,797—John D. Morgan, assignor to Cities Service Oil Company. A high temperature grease consisting of petrolatum having dispersed therein from about 8% to about 14% by weight of a lithium soap based on the weight of the grease.

Inhibited Turbine Oil and the Corrosive Inhibitor Therefor—Patent #2,393,799—John D. Morgan and Russell E. Lowe, assignors to Cities Service Oil Co. A turbine oil composition comprised mainly of a refined mineral oil having a viscosity and other properties suitable for turbine lubrication, and a small percentage of a solution of sodium dichromate in tributyl phosphate, said sodium dichromote being present in the lubricating oil in such quantities as effectively to inhibit corrosion of steam turbine parts.

Valve Lubricants—Patent #2,393,800—John D. Morgan and Russell E. Lowe, assignors to Cities Service Oil Co. A lubricant consisting essentially of a mixture of stearamide and glyceryl mono ricinoleate in a ratio by weight of from about 1:4 to about 2:3.

Cutting Oil Base—Patent #2,393,927—Latimer D. Myers and Victor J. Muckerheide, assignors to Emery Industries, Inc. A cutting oil base consisting of substantially equal parts of an alkali metal rosin soap and a mono ester of a fatty acid of from 16 to 18 carbon atoms in chain length and a member of the class consisting of di and polyhydric alcohols.

Mineral Oil Composition—Patent #2,393,934—Orland M. Reiff and Harry J. Andress, Jr., assignors to Socony-Vacuum Oil Company, Inc. An improved mineral oil composition comprising a mineral oil fraction having in admixture therewith a minor proportion, sufficient to impart improvement to said mineral oil fraction, of an oil-soluble, phosphorus-and sulfur-containing reaction product obtained by reacting a phosphorus sulfide and an amide of an alkyl-substituted aromatic carboxylic acid.

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NEWS of the

New York Section

JANUARY 25 MEETING

The first meeting of the New York Section was held on January 25th, in the McGraw-Hill Auditorium. It was attended by approximately 100 members and guests who came from not only New York City Area but from Massachusetts, Connecticut, New Jersey, Ohio, Pennsylvania, and Washington, D. C.

Chairman D. D. Fuller opened the meeting by giving a brief outline of the manner in which the New York Chapter was formed. He also pointed out that permanent officers for this Chapter would be elected at the May Meeting.

Our surprise guest of the evening —Mr. C. E. Pritchard, President of the A.S.L.E.—was introduced and requested to speak to the group. The aims of the Society and the basic need of an organization of this type were clearly presented by him. Other points of interest, such as membership classification and the relationship between local chapters and the national organization, were discussed.

A very timely and interesting paper on the "Performance Characteristics of Modern Motor Oils" was presented by Mr. W. G. Perriguey, Automotive Engineer, Standard Oil Co. of N. J. His talk was illustrated with many slides. The development work behind these oils and the problems eliminated by their intelligent application were described.

The problem or confusion which now exists between the oil supplier, the filter manufacturers, the engine builders, and the fleet operators was discussed by Mr. W. C. Bauer of the Briggs Filtration Co., in his paper on the "Filtration of Lube Oils in Heavy-Duty Service." This paper precipitated a lively discussion during the latter part of our meeting.

The consumer's point of view with regard to the use of Heavy Duty Oils and their filtration in bus service was exceptionally well presented by Mr. W. H. Bean, Supervisor of Bus Maintenance, Surface Transportation Co., in his paper on "Field Experiences with Heavy Duty Oils." His method of testing and evaluating the various types of treated oils which have been developed over the past five years was of real interest to all. Also of note were his comments to the effect that the technological development of oils as illustrated by the present day additive-type oils was far in advance of engine design and that many of the existing engine lubrication problems could be minimized by changes in engine design.

Mr. C. M. Larson, Chief Consulting Engineer of Sinclair Refining Co., and newly elected Director of the A.S.L.E., was called upon for his comments on this subject. Mr. Larson briefly described the development work behind the Heavy-Duty Detergent Type Oils, their advantages and limitations in the various types of engines — gasoline, diesel, railroad, and aircraft. The future of additives was also stressed.

Mr. M. L. Langworth, of The Texas Co., was also called upon for his comments on the subjects discussed. He presented some interesting facts on treated oils and requested that some thought be given to a future discussion on the application of additives to lubricants other than engine oils.

The filter manufacturers' points of view on the subject of the filtration of Heavy Duty Oils were also presented by such interesting speakers as Mr. E. Gunn, Vice President of Fram Corp., and Mr. J. P. Kovacs, Chief Engineer of Purolator Products, Inc.

More interesting data on the performance characteristics of Heavy Duty Engine Oils were presented by Mr. J. R. Wiggins, Engineer of Philadelphia Transportation Co., Mr. E. N. Hatch, Senior Mechanical Engineer, New York City Transit System; Mr. S. G. Harris, Manager Sales Engineering, Petroleum Solvents Corp., and Mr. W. C. Condit, Automotive Engineer, Sun Oil Co.

Next meeting, which will be on March 8th, will be devoted to Synthetic Lubricants, a subject of great interest to those concerned with automotive and industrial plant lubrication.

—ANTHONY J. ZINO, JR.
Secretary-Treasurer

Philadelphia Section

The first dinner meeting of the Philadelphia Section was held February 12th at the Engineers Club with sixty-five members present. Officers were elected as follows: Chairman—Edgar S. Ross, Sun Oil Company; Vice-President — William P. Kuebler, Westinghouse Electric Corp.; Secretary-Treasurer — John H. Richards, Apex Alkali Products Company. National President C. E. Pritchard and Founder W. D. Hodson were present. The next meeting is scheduled for late April.

Milwaukee Section

The Milwaukee Section held its January meeting on Monday, January 21st, at which time Mr. J. K. Douglas, Development Engineer of the Oilgear Company spoke on "Oil in Positive Displacement Hydraulic Transmissions." The talk was extremely interesting and well received by the audience, and many of the group hope soon that they can see it in print. An active discussion followed the presentation of the paper.

The February meeting took place on Monday, February 18th, with Mr. D. W. Johnson, Manager of the Industrial Division, Standard Oil Company of Milwaukee, speaking on the subject of "Greases." His paper was very well received and an interesting discussion followed. Officers for the coming year will be elected at the April meeting.

—W. A. ALEXANDROFF
Secretary

Necrology

A.S.L.E. lost one of its colorful members with the tragic passing of Gerald F. "Jerry" Keeley who was Sales Engineer in the Chicago Office of the Alemite Industrial Department.

"Jerry" Keeley was thirty-eight years old and had been with the Alemite Industrial Department since August, 1933. Always smiling and jovial, he was greatly admired by friends in Alemite and outside circles, both for his pleasant personality and real ability.

He is survived by his brother, Robert E. Keeley, and his mother, Mrs. Lottie Keeley.

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SECTIONS

Chicago Section

The January meeting of the Chicago Section was held January 25th in the evening at Huyler's Restaurant, 310 S. Michigan Avenue, Chicago, and was called to order by Chairman W. F. Leonard, after which the minutes of the November 28th, 1945, meeting were read and approved. The Secretary announced that the mailing list will be revised prior to the next meeting and requested all changes of address to be sent to him.

The Chairman announced the National Convention will be held at the Stevens Hotel in Chicago on April 5th and 6th, pointing out that a number of very interesting papers will be presented at the meeting.

The Chairman also made a strong appeal for new members, both individual and sustaining.

Professor B. H. Jennings, National Secretary, appealed for contributions to and comments concerning "LUBRICATION ENGINEERING." He stressed the desire to make this publication as interesting and effective as possible and will welcome any suggestions to that end.

Mr. Leonard then made appointments of the chairmen and suggested memberships of the following committees for 1946:

Entertainment Committee—Mr. L. R. Kerns of L. R. Kerns Company, Chairman.

Membership Committee — Mr. S. A. Hastings of Crane Packing Company, Chairman.

Standards Committee — Mr. Kenneth D. Hartman of Pettibone Mulliken Corporation, Chairman.

Duties of Committees

In connection with the Committee selection it was pointed out that:

1. The principal objective of the Entertainment Committee will be to plan and stage the golf tournament sometime this summer.

2. The selection of the Membership Committee was made with the object in view of getting as broad a coverage of the field as possible in order to assist in active solicitation of new members.

3. The work of the Standards Committee being of exceptional importance it is the general intent to select a chairman, one year from a supplier and in alternate years from firms actively engaged in actual lubrication work. The membership of the committee is balanced as nearly as possible between suppliers and operating people also, in order to secure all viewpoints on this problem.

A very interesting paper was presented by Dr. Edgar S. Ross of the Sun Oil Company of Philadelphia, Pennsylvania, on the subject of "Mineral Lubricating Oils," discussing particularly the derivation, production and properties of Mineral Lubricating Oils and their specific use in the lubrication of refrigerating system compressors.

A very significant paper was also presented by Carl E. Schmitz, Chief Engineer of the Crane Packing Company on the general subject of "Mechanical Seals." Mr. Schmitz also pointed his paper toward the general subject of refrigeration so that the two papers complimented each other very well.

There was a definite interest in both papers and considerable discussion ensued which brought out interesting points.

Approximately eighty men were in attendance, even though the steel strike kept many away.

—ROBERT Q. SHARPE
Secretary-Treasurer

Cleveland-Youngstown Section

Mr. L. W. Fitch, Secretary-Treasurer of the Cleveland-Youngstown Section has reported that the February dinner meeting of the Section was held on February 26th at the Cleveland Engineering Society. There were 76 persons present for the dinner and 92 persons at the meeting, including visitors from Canton, Warren, Youngstown, Pittsburgh and Toledo.

James I. Clower, Professor of Machine Design at the University of West Virginia, was the speaker and his paper "Theory and Fundamentals of Lubrication" was well received. Professor Clower is the author of the well-known textbook "Lubricants and Lubrication."

The Section was happy to welcome as guests, at the meeting, four charming young ladies from the Engineering Department of the Cleveland Graphite Bronze Company.

The March meeting will be held on the 26th at the Cleveland Engineering Society. The Section has established the 4th Tuesday in the month as the regular meeting night and this date is now reserved by the Engineering Society. The speaker for this meeting will be Mr. Edwin Crankshaw of the Cleveland Graphite Bronze Company, a recognized authority on bearing design, and his subject will be "The Trend in Sleeve Bearing Design."

A trip through the Standard Oil Company of Ohio Refinery on the afternoon of April 23rd will precede the regular dinner meeting scheduled for that evening. The speaker will be Mr. A. J. Jennings, Vice President in Charge of Sales, for the Farval Corporation, and his subject will be "Centralized Systems of Lubrication."

Mr. D. J. Wangelin, representing the Pure Oil Company, Chicago, Illinois, is scheduled to speak at the May meeting and his subject will be entitled "Cutting Oils."

Pittsburgh Section

The January meeting was held on January 18th at Hotel Webster Hall and was preceded by a dinner with forty in attendance.

The meeting was opened by Chairman B. J. Lamport. The minutes of the last meeting were approved as read.

The Secretary read a financial report of the past year. He also announced that the members would be billed by the National Society for the 1946 dues. The new Secretary will send a statement to each member of the Pittsburgh Chapter for the $2.00 local dues.

The Chairman then called on G. L. Sumner for a report on the meeting in Chicago. Mr. Sumner gave a very fine report, outlining the changes in membership status. Also, that two Vice-Presidents would be elected at the annual meeting. One will be from the East and one from the Mid-West.

(*Continued on page* 39)

New Member Applications*

The following applications for membership have been received since December 15, 1945. Most of these have been already acted upon by the Admissions Committee and, at the present time, are members of the Society. This list, as a supplement to the complete membership list published in the December issue of "Lubrication Engineering," represents the Society's membership as of February 20, 1946.

ARMSHAW, JAMES WILLIAM
Sta-Vis Oil Co.
Sta-Vis Oil Co.
500 Minnesota Building
St. Paul, Minnesota

ASHBY, WILLIAM L.
Mohawk Refining Corp.
Mohawk Refining Corp.
472 Frelinghuysen Avenue
Newark, New Jersey

BARLEY, SAMUEL B.
Standard Oil Co. of Penna.
Standard Oil Co. of Penna.
35th St. and A.V.R.R.
Pittsburgh 1, Penna.

BAUZENBERGER, WILLIAM B.
Apex Alkali Prod. Co.
Apex Alkali Prod. Co.
Main and Rector Sts.
Philadelphia 27, Penna.

BEAVER, BASIL A.
Gray Co., Inc.
4308 Morningside Road
Minneapolis, Minn.

BULLARD, ROBINSON D.
The Bullard Company
P. O. Box 564
Southport, Conn.

CAIRNS, G. A.
The Macco Products Co.
The Macco Products Co.
525 W. 76th Street
Chicago 20, Illinois

CALLAGHAN, ANDY
American Oil and Grease Corp.
28 N. Karlov Avenue
Chicago 24, Illinois

CALVERLEY, H. R.
Shell Oil Co., Inc.
Shell Oil Co., Inc.
2201 W. 3rd Street
Cleveland, Ohio

CARSON, RALPH W.
Alemite Co.
No. 9 Beverly Drive
R. D. No. 1
Wescoesville, Penna.

DEVER, HUBERT J.
Alemite Co. of Eastern Pa.
Alemite Co. of Eastern Pa.
704 N. 16th Street
Philadelphia 30, Penna.

DONALDSON, JOHN
Apex Alkali Prod. Co.
Apex Alkali Prod. Co.
Main and Rector Sts.
Philadelphia 27, Penna.

EDGHILL, JAMES GEOFFREY BRUCE
Esso Standard Oil (Antilles) SA
Esso Standard Oil (Antilles) SA
19 Water Street
Georgetown, British Guiana

FARRINGTON, BRUCE B.
California Research Corp.
California Research Corp.
P. O. Box 1627
Richmond, California

GEEN, CORY P.
Sun Oil Co.
"Glencrest" R.D. No. 1
Chalfont
Bucks County
Penna.

GIEG, CHARLES F.
Shell Oil Co., Inc.
Shell Oil Co., Inc.
1725 E. Market Street
Akron, Ohio

GODSHALL, J. BYRON
Ingersoll-Rand Co.
309 N. Tenth Street
Easton, Penna.

GREEN, ARTHUR W.
The Ironsides Co.
1745 E. 71st Place
Chicago 49, Illinois

GRENIER, JOHN C.
Chevrolet Motor Co.
Flushing Road 1605
Flint 4, Michigan

HARRIS, SIDNEY GERALD
Petroleum Solvents Corp.
155 Chilton Street
Elizabeth, New Jersey

HICKEL, ALBERT E.
Petroleum Research Abstracts
Petroleum Research Abstracts
30 W. Washington St.
Chicago 2, Illinois

HOFFMANN, STANLEY ROBERT
Dodge Chicago
Dodge Chicago
7401 Cicero Avenue
Chicago, Illinois

HOLMES, ROBERT L.
Ternstedt Mfg. Co.
1403 Liberty Avenue
Lincoln Park 25, Michigan

IRGENS, F. T.
Evinrude Motors
Evinrude Motors
4143 N. 27th Street
Milwaukee 9, Wisconsin

JESTER, S. VAN T., JR.
Shell Oil Co., Inc.
Shell Oil Co., Inc.
50 W. 50th Street
New York 20, New York

JOHNSON, MARTIN A., JR.
Socony Vacuum Oil Co.
Socony Vacuum Oil Co.
59 E. Van Buren Street
Chicago, Illinois

JONES, H. R., JR.
Gulf Oil Corp.
202 Pennsylvania Blvd.
Pittsburgh 16, Penna.

KUEBLER, WILLIAM P.
Westinghouse Electric Corp.
2334 Franklin Avenue
Secane, Penna.

LAMPMAN, EDWIN A.
Acheson Colloids Corp.
Acheson Colloids Corp.
200 Magee Building
Pittsburgh, Penna.

LA TOUR, CLIFFORD S.
E. F. Houghton and Co.
9815 Yates Avenue
Chicago 17, Illinois

LIBERTHSON, LEO
L. Sonneborn Sons, Inc.
L. Sonneborn Sons, Inc.
88 Lexington Avenue
New York 16, New York

McNARY, S. S.
The Texas Company
The Texas Company
31 Terminal Way
Pittsburgh 19, Penna.

McPHEE, JOHN R.
The Ironsides Co.
P. O. 1409
Poland, Ohio

MEYER, ARTHUR E.
Meyer Sheet Metal Mach'y Co.
Meyer Sheet Metal Mach'y Co.
1928 Santa Fe Avenue
Los Angeles 21, Calif.

MULLER, HENRY
Shell Oil Co., Inc.
318 W. 106th Street
New York 25, New York

MURPHY, HARRY A.
Gray Company, Inc.
Gray Company, Inc.
60—11 St. N.E.
Minneapolis 13, Minn.

NAGEL, JOHN Q.
Essex Brass Corp.
Essex Brass Corp.
2000 Franklin St.
Detroit 7, Michigan

NIEDERLOH, EARL L.
Gray Company, Inc.
Gray Company, Inc.
60—11th Avenue, N.E.
Minneapolis 13, Minn.

PERRIGUEY, WILBUR G.
Standard Oil Co. of N. J.
39-07 210th Street
Bayside
Long Island, New York

RICHARDS, GEORGE W. II
Apex Alkali Prod. Co.
Apex Alkali Prod. Co.
Main and Rector Sts.
Philadelphia 27, Penna.

SAS, ROBERT G.
Allis Chalmers Mfg Co.
3614 W. Rogers St.
Milwaukee 4, Wisconsin

SCHLEICHER, ROWELL A.
Black Bear Company, Inc.
Black Bear Company, Inc.
44-45 23rd Street
Long Island City 1, N.Y.

SCRIBA, ANTHONY M.
Honan-Crane Corp.
2221 S. California Avenue
Chicago, Illinois

SIEFERS, H. KENNETH
United Oil Co.
United Oil Co.
1800 N. Franklin St.
Pittsburgh 12, Penna.

SLOMER, JOS. J.
Goodman Mfg. Co.
7416 Bennett Avenue
Chicago 49, Illinois

TEAL, PERCY P.
Alemite Co. of Eastern Penna.
Alemite Co. of Eastern Penna.
704 N. 16th Street
Philadelphia, Penna.

VAN DER BURCH, DIRK
Shell Oil Co., Inc.
1130 West 7th Avenue
Gary, Indiana

WILKE, ADOLPH PETER
Omar Bakery, Inc.
Omar Bakery, Inc.
2130 W. Clybourn St.
Milwaukee 3, Wisconsin

WUNDERLICH, RALPH THOMAS
Lincoln Electric Co.
3794 Monticello Boulevard
Cleveland Heights 21, Ohio

**Company affiliations are given in italics—addresses indicated are preferred mailing addresses.*

Corrections and Address Changes

The following members have changed their address since December 15, 1945. Included also are correct spellings and company affiliations of members:

BRACE, R. LYLE
Brace Engineering Company
Brace Engineering Company
915 Valley Street
Dayton 4, Ohio

BROWN, ELTON S.
Standard Oil Co. (N. J.)
Standard Oil Co. (N. J.)
P. O. Box 32
Fairmont, West Virginia

DE MARTONFALVY, IVAN CHARLES
Uni-Gun Lubricating Equipment Ltd.
36 Garden Close
Ruislip
Middlesex, England

DEUTSCH, WILBUR
Brooks Equipment Co.
Brooks Equipment Co.
636 Potrero Avenue
San Francisco 10, Calif.

EWBANK, WALTER JAMES
Briggs Filtration Company
Briggs Filtration Company
Bethesda 14, Maryland

FREDERICKS, DONALD E.
L. R. Kerns Co.
6948 Paxton Avenue
Chicago, Illinois

HOFFMAN, STANLEY R.
Standard Oil Co. (Indiana)
9136 S. Winchester Avenue
Chicago 20, Illinois

MAHNCKE, HENRY E.
Westinghouse Research Laboratories
Westinghouse Research Laboratories
East Pittsburgh, Penna.

MARIS, JOHN H.
L. R. Kerns Co.
L. R. Kerns Co.
5579 Pershing Avenue
St. Louis 12, Missouri

MOUNTCASTLE, HENRY RICHARD
Swan-Finch Oil Corp.
P. O. Box 6327
Pittsburgh 12, Penna.

NEWMAN, THOMAS HART ODELL
Esso Standard Oil, S. A.
255-50 Northern Boulevard
Great Neck, New York

ORMSBY, GEORGE W.
Standard Oil Co. (Ind.)
512 Lakeview Avenue
Port Huron, Michigan

POWERS, S. L.
Honan-Crane Corp.
Honan-Crane Corp.
606 Williamson Building
Cleveland 14, Ohio

SCHWARTZ, DANIEL M.
Eimco Corp.
Eimco Corp.
P. O. Box 300
Salt Lake City 8, Utah

SIPCHEN, JOHN H.
J. H. Sipchen and Co.
Trabon Engineering Corp.
J. H. Sipchen and Co.
Trabon Engineering Corp.
549 W. Washington Boulevard
Chicago 6, Illinois

THUREN, ARTHUR I.
Swan-Finch Oil Corp.
Swan-Finch Oil Corp.
201 N. Wells Street
Chicago 6, Illinois

UHL, P. W.
Detroit Diesel Engine Div.
Detroit Diesel Engine Div.
13400 W. Outer Drive
Detroit 13, Michigan

WITHROW, RAYMOND C.
Freedom-Valvoline Oil Co.
Freedom-Valvoline Oil Co.
1008 Peoples Bank Building
Pittsburgh, Penna.

Pittsburgh Section

(*Continued from page* 37)

As there was no other business, the annual election took place. The following were elected officers of the Pittsburgh Chapter for the year 1946:

CHAIRMAN—
E. B. Svenson, Sr.
Aluminum Co. of America
New Kensington, Pa.

VICE-CHAIRMAN—
Mark A. Stillwagon
Carnegie-Illinois Steel Corp.
Homestead, Pa.

SECRETARY-TREASURER—
George H. Davis
1102 Grant Building
Shell Oil Co., Pittsburgh, Pa.
Phone: Atlantic 2731

PROGRAM CHAIRMAN—
Henry E. Mahncke
Westinghouse Electric Corp.
E. Pittsburgh, Pa.

MEMBERSHIP CHAIRMAN—
W. E. Lewis
Pure Oil Company
Pittsburgh, Pa.

ENTERTAINMENT CHAIRMAN—
H. W. White
Atlantic Refining Company
Pittsburgh, Pa.

Chairman Lamport then thanked the retiring officers and the members for their fine cooperation during 1945. He also wished the new officers the best of luck for the coming year.

The meeting was then turned over to the new Chairman, E. B. Svenson, Sr., who requested the new committee chairmen to select their committee members as soon as possible.

Mr. Svenson also announced that D. E. Whitehead of Carnegie-Illinois Steel Corporation would present a paper on "Spraying of Gear Lubricants" at the February 15th meeting.

There being no further business the meeting adjourned.

—WILBUR DEUTSCH

* * *

Mr. George H. Davis, Secretary of the Pittsburgh Section for 1946, made the following report.

The February meeting was held February 15th at the Hotel Webster Hall. Dinner was served to the thirty-eight who were present and several more dropped in later for the business session.

The meeting was opened by E. B. Svenson, Sr. The minutes of the last meeting were read and approved. The treasurer's report was read and approved.

Chairman Svenson discussed the annual convention to be held in Chicago, April 5-6 and asked all who could possibly attend to do so in order that the Pittsburgh section be well represented. Ten of our members signified that they would be present.

Mr. G. L. Sumner discussed the change in the by-laws to have four vice-presidents based on geographical areas. The consensus of opinion of the Pittsburgh Section was that each chapter should be represented nationally either by a vice-president or by a director. Mr. E. M. Kipp discussed the program for the annual meeting and stressed the fact that we are fortunate in securing such outstanding men to present papers at the convention.

The membership committee reported that two new members have been secured since the last meeting. After considerable discussion the membership committee was authorized by a motion duly carried to spend up to $50 for publishing and printing a brochure to be used in soliciting new members for the association. This brochure is to be ready by the next meeting.

Considerable discussion arose over the motion to hold the regular May meeting in Wheeling, West Virginia. This was brought up by the desires of the members from Wheeling in an effort to arouse further interest in this highly industrialized area. It was moved and seconded to hold the May meeting in Wheeling and the motion was passed.

Mr. Svenson then turned the meeting over to Mr. H. E. Mahncke, chairman of the Program Committee, who introduced Mr. D. E. Whitehead of the Carnegie-Illinois Steel Corporation. Mr. Whitehead gave a very interesting and informative discussion on "The Spraying of Gear Lubricants." Mr. Whitehead's paper aroused considerable discussion in the open meeting that followed the presentation.

News Item

The Shenango-Penn Mold Company of Dover, Ohio, has recently brought out two pamphlets describing their complete line of centrifugal castings. These are of particular interest to lubrication engineers concerned with bearings.

NATIONAL COMMITTEES

of

THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Nominating Committee:

D. F. HOLLINGSWORTH, Chairman
E. I. duPont deNemours and Company
1007 Market Street
Wilmington 98, Delaware
D. D. FULLER
H. C. KRAEMER

Program, Planning and Publications Committee:

E. M. KIPP, Chairman
Aluminum Company of America
New Kensington, Pa.
H. A. AMBROSE
D. F. HOLLINGSWORTH
R. G. LARSEN
N. C. PENFOLD
D. D. FULLER
W. S. MCKEE

Finance Committee:

D. N. EVANS, Chairman
Inland Steel Company
East Chicago, Indiana
B. H. JENNINGS, ex-officio

Membership Committee:

C. A. BAILEY, Chairman
Carnegie-Illinois Steel Corp.
Gary Works
Gary, Indiana

By-Laws Committee:

D. E. WHITEHEAD, Chairman
Carnegie Illinois Steel Corp.
Carnegie Building
Pittsburgh, Pa.

AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Grades of Membership

Membership in the Society is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

MEMBERS

Members shall be: (1) persons not less than twenty-four years in age who are engaged in research and instruction at technical schools, universities and various publicly and privately supported institutions in the field of lubrication; or (2) persons not less than twenty-four years in age who have occupied recognized positions as Lubrication Engineers for a period of three or more (not necessarily consecutive) years prior to date of admission, involving the responsibility for or supervision of the development, selection, field use and application of lubricants as differentiated from other activities; or (3) persons not less than twenty-four years in age who are indirectly concerned with the field of lubrication, but possessing other qualifications of experience, knowledge and accomplishment, have manifested a particular interest in the purposes and welfare of the Society, to the extent that their membership would be a valuable contribution to the successful functioning of its activities.

$10.00

JUNIOR MEMBERS

Junior Members shall be: persons less than twenty-four years in age, and those who do not completely fulfill the membership requirements for Members.

$5.00

SUSTAINING MEMBERS

Sustaining members are such persons or organizations as may be interested in and desire to contribute to supporting the purposes and activities of the Society. The fees paid by a sustaining member in general will not be allowed to exceed $200.00 per year.

WE make these surveys right along, and they result in a common-sense plan to assure correct application of the right lubricants. Briefly, this is what the Shell Lubrication Engineer will provide:

1. Survey and analysis of the lubrication requirements of your plant engines and machines.

2. Recommendations of proper lubricants, together with specific instructions as to when and how they should be used.

3. Scheduled check-ups for all critical or unusual machinery.

4. Reports (if you want reports) about the performance and economies of recommended lubricants in use in your machines. To the Shell Lubrication Engineer, though, the best report is short and sweet: "All machines continuously in service, well lubricated."

* * *

Right here we ought to warn you that the Shell Lubrication Engineer isn't going to tell you everything you're doing is wrong—he may, in fact, find very little fault with the lubricants and procedure you are now using.

Then, too, he will come to you without a rigid set of rules. Your lubricating procedures are probably based on pretty sound experiences that your own folks have had. Your problem is really one of picking out the weak spots before they become trouble spots . . .

So call the Shell Lubrication Engineer for that survey. If your property is so large that he needs help, he will have it. You are bound to gain, if it is only peace of mind!

There is no obligation on your part.

Call your local Shell Representative, or write Shell Oil Company, Incorporated, 50 W. 50th Street, New York 20, N. Y., or 100 Bush Street, San Francisco 6, California.

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THE "FOUR HORSEMEN" OF LUBRICATION

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TWO MORE HODSON FIRSTS

No. 1225 EMULSIFIER BASE

For Cutting, Drawing and Broaching Solutions

No. 1226 PALM OIL EMULSIFIER BASE

For Cold Rolling Ferrous and Non-Ferrous Metals

Both of these Emulsifier Bases are 100% Lubricant, completely emulsifiable in water. They contain no mineral oil, fillers or other diluents.

The Solutions thereof, which may contain as little as ½ of 1% Base to 99½% Water, have unusual qualities of: (1) Wetting, (2) Stability, (3) Extreme Pressure, (4) Anti-Rust, (5) With greater tool life and production, superior finish, at lower cost.

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Lubrication Manufacturers, Engineers and Consultants

5301-11 West 66th Street, Chicago 38, Ill.

OTHER OFFICES:

916 Union Trust Building
Telephone, Atlantic 9023
Pittsburgh 19, Pa.

907 Market St. National Bank B'dg.
Telephone, Rittenhouse 8307
Philadelphia 7, Pa.

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